

APPENDICES

YELL326141

APPENDIX A

Categorical Exclusion Documents

Project Title: **Canyon Ballfield Modulares (Goal I Housing)**
Milestones# 2023-158

PEPC Project Number: **121583**

Recommended by the following compliance specialists:

NEPA - Compliance Branch Chief

Digital Signature:

CHRISTINE
GABRIEL

Digitally signed by CHRISTINE
GABRIEL
Date: 2025.09.16 13:54:11 -06'00'

NHPA - Cultural Resources Branch Chief

Digital Signature:

TOBIN ROOP

Digitally signed by TOBIN ROOP
Date: 2025.09.18 11:45:15 -06'00'

Compliance Package Prepared By: **Bonnie McDonald**

Superintendent Review and Approval

The Environmental Screening Form has been reviewed.

AND

The Assessment of Actions Having an Effect on Historic Properties has been reviewed. The proposed work conforms to the *NPS Management Policies* and *Cultural Resource Management Guideline*, and I have reviewed and approve the recommendations, stipulations, or conditions noted in Section C of this form.

AND

The Categorical Exclusion has been reviewed. Decision: I find that the action fits within the categorical exclusion below. Therefore, I am categorically excluding the described project from further NEPA analysis. No extraordinary circumstances apply.

Superintendent Approval

Digital Signature:

CAMERON
SHOLLY

Digitally signed by CAMERON
SHOLLY
Date: 2025.09.19 06:26:09 -06'00'



Categorical Exclusion Documentation Form (CE Form)

Project: Canyon Ballfield Modulares (Goal I Housing)

PEPC Project Number: 121583

Description of Action (Project Description):

Yellowstone National Park (YNP) is located in a remote area, mostly surrounded by publicly-owned land. Housing costs in Gardiner and the surrounding area have risen sharply in recent years, with the average home price in Gardiner being in the \$850,000 range. Consequently, few of the park's employees can afford to live outside the park. Housing inside the park is scarce and often in poor condition, although YNP is in the midst of a multi-year effort to improve existing housing. However, the park does not contain enough housing to accommodate the year-round employees necessary for park operations. The housing shortage has negatively impacted YNP's ability to attract qualified employees to fill permanent positions. As a result, YNP is proposing to increase employee housing units in a variety of locations and configurations, including in the Canyon administrative area.

Yellowstone National Park proposes to install 10 modular employee housing units along the existing Canyon Government Area Road/Badger Road. The area is currently used as a boneyard for material storage and is situated between existing National Park Service employee housing and office space and a contractor RV park. The proposed residential units would be of modular construction, two-bedroom and two-bathroom, single-family homes with gabled roofs and front porches, installed on concrete foundations. They would be similar in type and construction to other recent housing in YNP. Additionally, the necessary utilities would be installed, and the existing dirt road would be widened and paved. See attached plans.

Temporary staging of construction materials would take place on the project site. The proposed action would be performed by an independent contractor beginning in May 2026.

YNP Cultural Resources staff determined that the proposed project would not have an adverse effect on historic properties. The housing units themselves would not be in view of any historic properties. Paving the area's access road, which ties into the Grand Loop Road, would not be an adverse effect the Grand Loop Road Historic District as there are currently dozens of paved access roads connecting to the district. There are no known archaeological resources within the area of potential effect. WY SHPO concurred Feb 20, 2025.

USFWS concurred with YNP's determination that the Project 'may affect but is not likely to adversely affect the Canada lynx, and the grizzly bear, is 'not likely to jeopardize the continued existence of the monarch butterfly and the Suckleys cuckoo bumble bee, would have 'no effect on the North American wolverine, the yellow-billed cuckoo, and the Ute ladies-tresses, and 'would not destroy or adversely modify designated Canada lynx critical habitat. The Services biological opinion states that the Project is not likely to jeopardize the continued existence of the whitebark pine with the incorporation of conservation measures. The anticipated level of whitebark pine removal caused by the proposed action would not appreciably reduce the overall population, reproduction, and distribution of whitebark pine throughout its range. See attachments within Other Compliance.

Certifications/Permitting:

The Environmental Protection Agency is the only valid certification authority for water quality. All necessary and required certifications (CWA 401, 402) and permits (CWA 404) must be in place before commencement of the activities described in this categorical exclusion.

Project Locations:

Location**County:** Park**State:** WY**Mitigation(s):**

- All wetlands within or adjacent to project areas must be avoided. Wetlands to be avoided will be marked on the maps/plans provided to construction contractor and flagged prior to start of work. Contact YNP Vegetation Program to schedule flagging.
- The Environmental Protection Agency is the only valid certification authority for water quality. All necessary and required certifications (CWA 401, 402) and permits (CWA 404) must be in place before commencement of the activities described in this categorical exclusion.
- UTE LADIES'-TRESSES Conservation Measures: • Herbicide spot treatments for infrastructure activities will maintain a minimum distance of 1 m (3.3 ft) from Ute ladies-tresses. Ground-based broadcast applications will maintain a minimum distance of 3 m (10 ft) from Ute Ladies-tresses. • Train project personnel to identify the species to ensure project activities do not result in more adverse effects than described in the project description. • Limit soil disturbance and compaction by limiting the use of mechanical equipment such as heavy equipment and vehicles. Control runoff of soil during project activities and avoid using machinery in wet soils and areas prone to ruts. • Minimize creation of dust when using mechanical equipment (heavy equipment and vehicles).
- YELLOW-BILLED CUCKOO: • Managers will ensure all participants, including collaborators, and volunteers, are given orientations on how to avoid disturbing or encountering a yellow-billed cuckoo and other wildlife, including regulations regarding vehicle speed limits, food storage, disposal of garbage and other attractants, and approaching or harassing wildlife. • When possible, managers will limit employee camps and equipment storage areas to existing support facilities to reduce disturbance. • Any observation of a yellow-billed cuckoo within the proposed action area would be reported to the wildlife biologist and appropriate action would be taken to reduce potential effects.
- GRIZZLY BEAR Conservation Measures: • Managers will ensure all participants, including contractors, collaborators, and volunteers, are given orientations on how to avoid disturbing or encountering bears and other wildlife, including regulations regarding vehicle speed limits, food storage, disposal of garbage and other attractants, and approaching or harassing wildlife. • Unless authorized, workers in YNP will avoid designated closure areas that have high historic use by grizzly bears during spring and summer, as well as closure areas around active bear dens to minimize wildlife disturbance and human-wildlife interactions. • When possible, managers will limit employee or contractor camps and equipment storage areas to existing support facilities to reduce disturbance. • During and after management activities, managers will take prevention and restoration measures to avoid the introduction of exotic invasive species and discourage the establishment of herbaceous foods such as clover.
- CANADA LYNX Conservation Measures: • Managers will ensure all participants, including contractors, collaborators, and volunteers, are given orientations on how to avoid disturbing, approaching, or harassing lynx and other wildlife. • When possible, managers will limit employee or contractor camps and equipment storage areas to existing support facilities to reduce disturbance. • Any observation of Canada lynx within the action area would be reported to the wildlife biologist and appropriate action would be taken to reduce potential effects.
- WHITEBARK PINE Conservation Measures: • Conduct pre-project surveys to identify WBP individuals of all age classes. • When marking is appropriate, clusters of whitebark pine trees will be marked (so they may be avoided) in a manner that does not cause damage to the tree or introduce disease. • Avoid ground disturbance from heavy equipment within whitebark pine stands and within 10 m (33 ft) of known whitebark pine trees, which will protect the roots and soil within the drip line of large, mature trees. • If using heavy equipment in whitebark pine stands cannot be avoided, equipment will be used sparingly and will be cleaned before entering and leaving work sites to prevent the spread of invasive species, pathogens, and pests. • Avoid off road motorized travel in whitebark pine habitat. • When working in whitebark pine stands, ensure work does not introduce or spread Ribes species that are an alternate host for white pine blister rust. • Herbicide spot treatments for infrastructure activities will maintain a minimum distance of 1 m (3.3 ft) from a whitebark pine tree. Ground-based broadcast applications will maintain a minimum distance of 3 m (10 ft) from the trunk of a whitebark pine tree. • Train project personnel to identify the species regardless of their age class (seedling, sapling, and mature trees) to ensure project activities do not result in more adverse effects than described in the project description. • Wherever possible, avoid removing or damaging

healthy, unsuppressed whitebark trees. Limit soil disturbance and compaction by limiting the use of mechanical equipment such as heavy equipment and vehicles. Control runoff of soil during project activities and avoid using machinery in wet soils and areas prone to ruts. • Minimize creation of dust when using mechanical equipment (heavy equipment and vehicles).

- SUCKLEY'S CUCKOO BUMBLE BEE Conservation Measures: • To the extent feasible, no nectar feeding plants or host plant species for Suckleys cuckoo bumble bee will be removed during management activities. • If habitat disturbance is necessary, project managers will try to adjust the timing of activities in areas containing plants used by Suckleys cuckoo bumble bee to avoid interfering with breeding or feeding. • To the extent feasible, managers will avoid using pesticides or herbicides in Suckleys cuckoo bumble bee habitat that could result in direct mortality or eliminate host and nectar plants. • If pesticide application is necessary near Suckleys cuckoo bumble bee habitat, managers will select chemical formulations specific to the targeted pest, time applications to avoid activity periods, establish buffers, and minimize drift to non-target areas by direct ground application.
- MONARCH BUTTERFLY Conservation Measures: • To the extent feasible, no nectar feeding plants or host plant species for monarch butterflies or caterpillars will be removed during management activities.
 - If habitat disturbance is necessary, project managers will try to adjust the timing of activities in areas containing plants used by monarchs to avoid interfering with breeding or feeding.
 - To the extent feasible, managers will avoid using pesticides or herbicides in monarch butterfly habitat that could result in direct mortality or eliminate host and nectar plants.
 - If pesticide application is necessary near monarch butterfly habitat, managers will select chemical formulations specific to the targeted pest, time applications to avoid monarch activity periods, establish buffers, and minimize drift to non-target areas by direct ground application.
- WOLVERINE Conservation Measures: • Managers will ensure all participants, including contractors, collaborators, and volunteers, are given orientations on how to avoid disturbing or encountering wolverines and other wildlife, including regulations regarding vehicle speed limits, food storage, disposal of garbage and other attractants, and approaching or harassing wildlife.
 - When possible, managers will limit employee or contractor camps and equipment storage areas to existing support facilities to reduce disturbance.
 - Any observation of wolverines within the proposed action area would be reported to the wildlife biologist and appropriate action would be taken to reduce potential effects.
- All equipment and tools shall be cleaned completely prior to entering the work zone to prevent the spreading of non-invasive plant seeds. Equipment shall be inspected for compliance. (This General Conservation Measure was specified in USFWS Biological Opinion).
- All erosion and sediment control devices shall be adequately maintained to assure continued performance of their intended function. Those that have sustained damage or have reached their capability shall be replaced or maintenance performed. (This General Conservation Measure was specified in USFWS Biological Opinion).
- All material brought into the park from outside sources must be certified weed-free fill obtained from a recently certified facility. Please contact the Yellowstone Center for Resources (YCR) for the most up to date list of certified facilities in the GYE. (This General Conservation Measure was specified in USFWS Biological Opinion).
- Ground disturbance from heavy equipment will be avoided within whitebark pine stands and within 10 meters (m; 33 feet) of known whitebark pine trees, which will protect the roots and soil within the drip line of large, mature trees. (This Whitebark Pine Conservation Measure was specified in USFWS Biological Opinion).
- When marking is appropriate, clusters of whitebark pine trees will be marked (for avoidance) in a manner that does not cause damage to the tree or introduce disease. (This Whitebark Pine Conservation Measure was specified in USFWS Biological Opinion).
- Off road motorized travel in whitebark pine habitat will be avoided. (This Whitebark Pine Conservation Measure was specified in USFWS Biological Opinion).
- Train project personnel to identify the species regardless of their age class (seedling, sapling, and mature trees) to ensure project activities do not result in more adverse effects than described in the project description. (This Whitebark Pine Conservation Measure was specified in USFWS Biological Opinion).
- Wherever possible, avoid removing or damaging healthy, unsuppressed whitebark trees. Limit soil disturbance and compaction by limiting the use of mechanical equipment such as heavy equipment and vehicles. Control runoff of

soil during project activities and avoid using machinery in wet soils and areas prone to ruts. (This Whitebark Pine Conservation Measure was specified in USFWS Biological Opinion).

- Herbicide spot treatments for infrastructure activities will maintain a minimum distance of 1 m (3.3 feet) from a whitebark pine tree. Ground-based broadcast applications will maintain a minimum distance of 3 m (10 feet) from the trunk of a whitebark pine tree. (This Whitebark Pine Conservation Measure was specified in USFWS Biological Opinion).
- Ensure work crews adhere to bear safety and food storage regulations.
- The project lead will ensure that all project-related employees, such as contract employees, would be given orientation on how to avoid disturbing or encountering bears and how to minimize unavoidable effects or encounters. Orientation would include information about park regulations regarding food storage, disposal of garbage and other bear attractants, and approaching or harassing wildlife.
- If using heavy equipment in whitebark pine stands cannot be avoided, equipment will be used sparingly and will be cleaned before entering and leaving work sites to prevent the spread of invasive species, pathogens, and pests. (This Whitebark Pine Conservation Measure was specified in USFWS Biological Opinion).
- Pre-project surveys will be conducted to identify whitebark pine individuals of all age classes. (This Whitebark Pine Conservation Measure was specified in USFWS Biological Opinion).
- When working in whitebark pine stands, work will not introduce or spread *Ribes* species that are an alternate host for white pine blister rust. (This Whitebark Pine Conservation Measure was specified in USFWS Biological Opinion).
- All workers will be informed of the criminal penalties for illegally collecting historic objects and/or artifacts or intentionally damaging any archeological or historic property. Workers will also be informed of the correct procedures should cultural resources be uncovered during construction activities. Cultural resources will be identified and documented by a professional archaeologist, historian, or museum curator (as appropriate) that meets SOI and NPS standards, and an appropriate mitigation strategy will be developed, if necessary, in accordance with pertinent laws and regulations, including the stipulations of the 2008 Programmatic Agreement Among the National Park Service (U.S. Department of the Interior), the Advisory Council on Historic Preservation, and the National Conference of State Historic Preservation Officers.
- If previously unknown archeological resources are discovered during construction activities, all ground disturbing activities in the immediate vicinity (300 feet) of the discovery shall be halted and the Park Archaeologist notified immediately. Cultural resources will be identified and documented by an archaeologist meeting the NPS Qualification Standards and the Secretary of the Interior's Professional Qualification Standards. An appropriate mitigation strategy will be developed, if necessary, in accordance with pertinent laws and regulations.
- In the event that human remains or other items that fall under the purview of NAGPRA are discovered during construction activities, all work on the project must stop and the park archaeologist contacted immediately. As required by law, the coroner will be notified first. All provisions outlined in the Native American Graves Protection and Repatriation Act (1990) will be followed.
- Project will ensure vegetation continues to screen views of development (such as the NPS government areas) from the Grand Loop Road Historic District (48YE520) by retaining trees of varied maturation that provide both understory and canopy trees.
- To avoid impacts to migratory birds during nesting season, please consider conducting all vegetation removal activities outside of March 1 - August 15th for raptors, and May 1 - August 15th for songbirds. If you are within the March 1 - August 15 window, and you suspect active nests from detection of physical structures (e.g. large collections of sticks or smaller plant material in nest-like shape, cavity holes) or behaviors (e.g. birds in and out of tree cavities, activity at nest-like structures in trees, birds carrying food into nest-like structures), please contact the Bird Program Manager at 307-344-2218 or david_b_haines@nps.gov to discuss or schedule a survey.
- To minimize the amount of ground disturbance, staging and stockpiling areas shall be located in previously disturbed sites, away from visitor use areas to the greatest extent possible. All staging and stockpiling areas shall be returned to pre-construction conditions following construction.
- To the extent practical, work shall be scheduled to avoid construction activity and construction related delays during peak visitation times. No holiday or night time work shall be allowed. Weekend work (Friday through Sunday) shall not be allowed unless authorized in writing by the park's Superintendent.
- Project manager will ensure residents are properly notified of project related activities including closures, detours, power outages, and invasive plant treatment as necessary, prior to commencement of the aforementioned activities.

- Contractors would coordinate with park staff to reduce disruption in normal park activities (i.e. facilitate emergency traffic, and hauling material, to allow for visitor use in areas where no conflicts or safety concerns exist).
- To minimize the amount of ground disturbance, staging and stockpiling areas would be located in previously disturbed sites if at all possible. All staging and stockpiling areas would be returned to pre-construction conditions following construction. Construction zones and staging areas would be identified and fenced with construction tape, snow fencing, or some similar material prior to any construction activity. The fencing would define the construction zone and confine activity to the minimum area required for construction.
- Please contact your compliance representative if the scope of work changes to ensure proper compliance documentation has been completed. Upon project completion, please send a written summary, with photos if possible, to close out the administrative record for your project.
- Project shall comply with NPS and park lighting guidelines to reduce impacts to the night sky and wildlife. This will include, but is not limited to, low-level lighting, minimized glare, downward focused light fixtures, and energy efficient light sources such as low-pressure sodium lamps.
- Line locates must be completed before any excavation work may begin. The depth of utility line varies and there may be multiple utility lines in a common area. Digging without calling can disrupt service, harm you and those around you and potentially result in fines and repair costs. Calling 811 before every job gets underground utility lines marked for free and helps prevent undesired consequences.
- Any and all historic objects discovered during this project (i.e. under foundations, in wall, attic, or crawl spaces, etc.) remain property of the federal government and shall be considered by the YELL Collections Committee for accessioning into the park unit's museum collection whether they are stored at an NPS facility or placed on loan to an agreed upon repository.
- The project lead will ensure that all project-related employees, such as contract employees, would be given orientation on how to avoid disturbing or encountering bears and how to minimize unavoidable effects or encounters. Orientation would include information about park regulations regarding food storage, disposal of garbage and other bear attractants, and approaching or harassing wildlife.
- Ensure work crews adhere to bear safety and food storage regulations.

CE Citation: 3.3.C.18 Construction of minor structures, including small improved parking lots, in previously disturbed or developed areas.

CE Justification:

This project proposes to infill modular housing within the previously disturbed area of the established Canyon administrative area. There would be no significant impact to natural or cultural resources by the project as proposed, providing mitigation measures are followed. Therefore, Categorical Exclusion 3.3.C.18 applies.

Decision: I find that the action fits within the categorical exclusion above. Therefore, I am categorically excluding the described project from further NEPA analysis. No extraordinary circumstances apply.

Extraordinary Circumstances:

If implemented, would the proposal...	Yes/No	Explanation
A. Have significant impacts on public health or safety?	No	The project proposal to build ten housing units in the Canyon administrative area would have positive impacts to employee health and safety. These units would provide safe and secure housing for several National Park Service families. These families would be able to join an established housing area with mental health services, fitness center, daycare services, and a preschool which would provide a sense of security and community.
B. Have significant impacts on such natural resources and unique geographic characteristics as historic or cultural resources; park, recreation or refuge lands; wilderness areas; wild or scenic rivers; national natural landmarks; sole or principal drinking water aquifers; prime farmlands; wetlands; floodplains; national monuments; migratory birds; and other ecologically significant or critical areas?	No	This proposed project occurs within a previously disturbed area within the Canyon administrative area. It would not have significant impacts on natural or cultural resources. It would occur outside the recommended wilderness boundary. It does not have impacts to wild or scenic rivers, landmarks, floodplains, national monuments, migratory birds or ecologically critical or significant areas. The road improvement would impact a small section of roadside ditch wetlands. The proposed action would permanently impact 0.033 acres (48.29 cu yd) of roadside ditch wetlands. Construction would temporarily impact 0.001 ac (4.87 cu yd) wetlands. This impact is not significant.
C. Have highly uncertain and potentially significant environmental effects or involve unique or unknown environmental risks?	No	This circumstance does not apply because the project is occurring within the footprint of previous disturbance. The proposed project does not have highly uncertain or potentially significant environmental impacts or risks.
D. Establish a precedent for future action or represent a decision in principle about future actions with potentially significant environmental effects?	No	This project does not establish a precedent for future action because potential future projects with similar scope are unlikely to have the potential for significant environmental effects. The infill of housing within established housing areas would be a sustainable mechanism to address shifting park needs while limiting the expansion of developed areas and the overall building footprint parkwide.
E. Have a direct relationship to other actions that implicate potentially significant environmental effects?	No	This extraordinary circumstance does not apply because the project is within the previous disturbance Lower Mammoth housing development. This project would occur within the previous footprint of a motor camp, so no new area would be disturbed and thus no new cumulatively significant environmental effects.
F. Have significant impacts on properties listed, or eligible for listing, on the National Register of Historic Places as determined by the bureau?	No	YNP Cultural Resources staff determined that the proposed project would not have an adverse effect on historic properties. The housing units themselves would not be in view of any historic properties. Paving the area's access road, which ties into the Grand Loop Road, would not be an adverse effect the Grand Loop Road Historic District as there are currently dozens of paved access roads connecting to the district. There are no known archaeological resources within the area of potential effect. WY SHPO concurred with this determination.

G. Have significant impacts on species listed, or proposed to be listed, on the List of Endangered or Threatened Species or have significant impacts on designated Critical Habitat for these species?	No	This extraordinary circumstance does not apply. The proposed action was reviewed by a YNP biologist who then consulted with USFWS. See Other Compliance section and attached correspondence within Internal Documents.
H. Significantly limit access to and ceremonial use of Indian sacred sites on Federal lands by Indian religious practitioners or significantly adversely affect the physical integrity of such sacred sites?	No	This is not applicable because access to and ceremonial use of indigenous sacred sites would not be limited.
I. Contribute to potentially significant effects resulting from the introduction, continued existence, or spread of noxious weeds or non-native invasive species known to occur in the area or from other actions that promote the introduction, growth, or expansion of the range of such species (Federal Noxious Weed Control Act)?	No	This project would not contribute to the introduction or spread of noxious weeds or nonnative invasive species because mitigations are in place to limit the spread of such vegetation.



ENVIRONMENTAL SCREENING FORM (ESF)

Updated Sept 2015 per NPS NEPA Handbook

A. PROJECT INFORMATION

Project Title: Canyon Ballfield Modulares (Goal I Housing)
PEPC Project Number: 121583
PMIS Number:
Project Type: Capital Improvement/New Construction (CI)
Project Location:
County, State: Park, Wyoming
Project Leader: Robert Kammel

B. PROJECT DESCRIPTION

Yellowstone National Park (YNP) is located in a remote area, mostly surrounded by publicly-owned land. Housing costs in Gardiner and the surrounding area have risen sharply in recent years, with the average home price in Gardiner being in the \$850,000 range. Consequently, few of the park's employees can afford to live outside the park. Housing inside the park is scarce and often in poor condition, although YNP is in the midst of a multi-year effort to improve existing housing. However, the park does not contain enough housing to accommodate the year-round employees necessary for park operations. The housing shortage has negatively impacted YNP's ability to attract qualified employees to fill permanent positions. As a result, YNP is proposing to increase employee housing units in a variety of locations and configurations, including in the Canyon administrative area.

Yellowstone National Park proposes to install 10 modular employee housing units along the existing Canyon Government Area Road/Badger Road. The area is currently used as a boneyard for material storage and is situated between existing National Park Service employee housing and office space and a contractor RV park. The proposed residential units would be of modular construction, two-bedroom and two-bathroom, single-family homes with gabled roofs and front porches, installed on concrete foundations. They would be similar in type and construction to other recent housing in YNP. Additionally, the necessary utilities would be installed, and the existing dirt road would be widened and paved. See attached plans.

Temporary staging of construction materials would take place on the project site. The proposed action would be performed by an independent contractor beginning in May 2026.

YNP Cultural Resources staff determined that the proposed project would not have an adverse effect on historic properties. The housing units themselves would not be in view of any historic properties. Paving the area's access road, which ties into the Grand Loop Road, would not be an adverse effect the Grand Loop Road Historic District as there are currently dozens of paved access roads connecting to the district. There are no known archaeological resources within the area of potential effect. WY SHPO concurred Feb 20, 2025.

USFWS concurred with YNP's determination that the Project 'may affect but is not likely to adversely affect the Canada lynx, and the grizzly bear, is 'not likely to jeopardize the continued existence of the monarch butterfly and the Suckleys cuckoo bumble bee, would have 'no effect on the North American wolverine, the yellow-billed cuckoo, and the Ute ladies-tresses, and 'would not destroy or adversely modify designated Canada lynx critical habitat. The Services biological opinion states that the Project is not likely to jeopardize the continued existence of the whitebark pine with the incorporation of conservation measures. The anticipated level of whitebark pine removal caused by the proposed action would not appreciably

reduce the overall population, reproduction, and distribution of whitebark pine throughout its range. See attachments within Other Compliance.

Certifications/Permitting:

The Environmental Protection Agency is the only valid certification authority for water quality. All necessary and required certifications (CWA 401, 402) and permits (CWA 404) must be in place before commencement of the activities described in this categorical exclusion.

C. RESOURCE IMPACTS TO CONSIDER:

Resource	Potential for Impact	Potential Issues & Impacts
Air Air Quality <i>Air Quality</i>	Potential	Issue: Exhaust and dust generated from construction activities and equipment Impact: Air quality would be temporarily degraded due to construction dust during the construction period. Local emissions from construction equipment would occur during this same time.
Biological Nonnative or Exotic Species <i>Nonnative plants</i>	Potential	Issue: Spread or introduction of nonnative vegetation. Impact: Nonnative plants may be spread or introduced during ground-disturbing activities or by equipment travel from one area to another. Mitigation measures and a vegetation management plan will be needed prior to implementation.
Biological Species of Special Concern or Their Habitat <i>Species protected by the Endangered Species Act</i>	Potential	Issue: Species protected by the Endangered Species Act may or do occur in the proposed action area Impact: USFWS concurred with YNP's determination that the Project 'may affect but is not likely to adversely affect the Canada lynx, (<i>Lynx canadensis</i>) and the grizzly bear (<i>Ursus arctos</i>), is 'not likely to jeopardize the continued existence of the monarch butterfly (<i>Danaus plexippus</i>) and the Suckleys cuckoo bumble bee (<i>Bombus suckleyi</i>), will have 'no effect on the North American wolverine (<i>Gulo gulo luscus</i>), the yellow-billed cuckoo (<i>Coccyzus americanus</i>), and the Ute ladies-tresses (<i>Spiranthes diluvialis</i>), and 'will not destroy or adversely modify designated Canada lynx critical habitat. The Services biological opinion states that the Project is not likely to jeopardize the continued existence of the whitebark pine with the incorporation of conservation measures. The anticipated level of whitebark pine removal caused by the proposed action will not appreciably reduce the overall population, reproduction, and distribution of whitebark pine throughout its range. See Internal Documents for consultation records.
Biological Vegetation <i>Forest</i>	Potential	Issue: Tree removal will be required to install utilities and the modular homes. Impact: Forests cover roughly 80% of Yellowstone National Park so the removal of trees within the proposed project area would have a small impact on the overall forests of Yellowstone.
Biological Wildlife and/or Wildlife Habitat including terrestrial and aquatic species <i>Wildlife Habitat</i>	Potential	Issue: Tree removal would be required to install utilities and the modular homes. Impact: Removal of some trees would negatively impact the micro-ecosystem dependent on those trees (insects, small mammals) until they were able to move to a nearby tree.

Cultural Archeological Resources <i>Archeological Resources</i>	Potential	Issue: Ground disturbance associated with this project could expose previously unknown archaeological resources. Impact: Ground disturbance work could damage or destroy previously unknown resources. However, a process is in place to inventory archaeological resources in areas not yet inventoried. See mitigations.
Cultural Cultural Landscapes <i>Cultural Landscapes</i>	None	Issue: New buildings within a previously disturbed area within an administrative area Impact: YNP Cultural Resources staff determined that the proposed project would not have an adverse effect on historic properties. The housing units themselves would not be in view of any historic properties. Paving the area's access road, which ties into the Grand Loop Road, would not be an adverse effect the Grand Loop Road Historic District as there are currently dozens of paved access roads connecting to the district. There are no known archaeological resources within the area of potential effect. WY SHPO concurred with these findings.
Cultural Ethnographic Resources <i>Ethnographic Resources</i>	Potential	Issue: Tribes have identified some plants and animals in the park that are ethnographically significant. Ground disturbance associated with this project could expose previously unknown ethnographic resources. Impact: Ground disturbance work could damage or destroy previously unknown resources. However, mitigations are in place if such resources are found during work. Additionally, if the project would disturb these resources the tribes will be consulted
Cultural Museum Collections <i>Objects and Specimens</i>	Potential	Issue: Ground disturbance associated with this project could expose previously unknown objects or specimens of interest by Yellowstone National Park museum staff. Impact: Ground disturbance work could damage or destroy previously unknown resources. However, mitigations are in place if such resources are found during work.
Cultural Prehistoric/historic structures	None	
Geological Geologic Features <i>Soils</i>	Potential	Issue: Ground disturbance is necessary for this project. Impact: Minor, short-and long-term impacts will occur to the geological resources in the project area due to excavation necessary to perform this project. This is a previously disturbed (housing) area. Mitigations are in place in the event that cultural resources are found during excavation.
Geological Geologic Processes <i>Geologic Processes</i>	None	Issue: Ground disturbance work could damage or destroy previously unknown resources. Impact: No known geologic resources in the area. However, mitigations are in place if such resources are found during work.
Lightscapes Lightscapes <i>Night Skies</i>	Potential	Issue: Potential light pollution

		Impact: Increasing housing capacity in the park will inherently increase the number of light sources available to contribute to the degradation of night skies. However, it is not expected that the implementation of this project would degrade the quality of night sky in the park to a point where it would be noticeably apparent.
Other Human Health and Safety <i>Employee health and safety</i>	Potential	Issue: Old housing units were infested with pests and badly deteriorated Impact: The health and safety of employees living in park housing would be greatly improved by removing the old trailer units and installing new modular housing.
Paleontological Paleontological Resources <i>Paleontological Resources</i>	None	Issue: Ground disturbance work could damage or destroy previously unknown resources. Impact: No known paleontological resources in the area. However, mitigations are in place if such resources are found during work.
Socioeconomic Land Use <i>Land Use</i>	Potential	Impact: Goal I housing would increase employee housing in Yellowstone National Park.
Socioeconomic Socioeconomic Factors <i>Socioeconomic Factors</i>	Potential	Impact: Goal I housing would increase employee housing in Yellowstone National Park.
Soundscapes Soundscapes <i>Soundscapes</i>	Potential	Issue: Construction noise Impact: Noise from construction activities may temporarily disrupt the experience of visitors at the Mammoth Campground, the residents of the Canyon housing area, and wildlife within the immediate vicinity. However, this is a temporary disruption and would occur during daytime hours.
Viewsheds Viewsheds <i>Viewsheds</i>	None	Issue: Additional housing units installed in administrative area Impact: The additional housing units would not impact the Grand Loop Road Historic District since there would be enough tree screening blocking the view.
Visitor Use and Experience Recreation Resources <i>Recreation Resources, NPS Staff</i>	Potential	Impact: The availability of safe, secure, and comfortable NPS-staff housing will help Yellowstone National Park maintain its workforce which would help keep the Park at a higher level of service for visitors.
Visitor Use and Experience Visitor Use and Experience <i>Visitor Use and Experience</i>	None	Impact: The proposed project would not impact visitor use or experience as construction would be during daylight areas and is within a NPS administrative area.
Water Floodplains <i>Floodplains</i>	None	Impact: There are no floodplains within the construction boundary of the proposed project.

Water Water Quality or Quantity <i>Water Quality or Quantity</i>	Potential	Issue: Temporary water (rain, snow-melt runoff) turbidity during ground disturbance. Impact: Negligible short-and long-term adverse impacts to water quality may occur during ground disturbance activities. Mitigations are in place to reduce/prevent the runoff of turbid water during rain events.
Water Wetlands <i>Wetlands</i>	Potential	Issue: Wetlands occur along one edge of roadway to be improved. Impact: The proposed action would permanently impact 0.033 acres (48.29 cu yd) of roadside ditch wetlands during road renovations. Construction would temporarily impact 0.001 ac (4.87 cu yd) wetlands. CWA 401/404 certification/permitting would be in place before impacts to wetlands.
Wilderness Wilderness <i>Wilderness</i>	None	Impact: The proposed action would occur outside of the recommended wilderness boundary.

D. ESF ADDENDUM QUESTIONS:

Question	Answer	Notes



ASSESSMENT OF ACTIONS HAVING AN EFFECT ON HISTORIC PROPERTIES

A. DESCRIPTION OF UNDERTAKING

1. Park: Yellowstone National Park

2. Project Description:

Project Name: Canyon Ballfield Modulares (Goal I Housing)

Prepared by: Alicia Murphy **Date Prepared:** 02/04/2025 **Telephone:** (307) 344-2627

PEPC Project Number: 121583

Locations:

County, State: Park, WY

Describe project:

Yellowstone National Park (YNP) is located in a remote area, mostly surrounded by publicly-owned land. Housing costs in Gardiner and the surrounding area have risen sharply in recent years, with the average home price in Gardiner being in the \$850,000 range. Consequently, few of the park's employees can afford to live outside the park. Housing inside the park is scarce and often in poor condition, although YNP is in the midst of a multi-year effort to improve existing housing. However, the park does not contain enough housing to accommodate the year-round employees necessary for park operations. The housing shortage has negatively impacted YNP's ability to attract qualified employees to fill permanent positions. As a result, YNP is proposing to increase employee housing units in a variety of locations and configurations, including in the Canyon administrative area.

Yellowstone National Park proposes to install 10 modular employee housing units along the existing Canyon Government Area Road/Badger Road. The area is currently used as a boneyard for material storage and is situated between existing National Park Service employee housing and office space and a contractor RV park. The proposed residential units would be of modular construction, two-bedroom and two-bathroom, single-family homes with gabled roofs and front porches, installed on concrete foundations. They would be similar in type and construction to other recent housing in YNP. Additionally, the necessary utilities would be installed, and the existing dirt road would be widened and paved. See attached plans.

Temporary staging of construction materials would take place on the project site. The proposed action would be performed by an independent contractor beginning in May 2026.

YNP Cultural Resources staff determined that the proposed project would not have an adverse effect on historic properties. The housing units themselves would not be in view of any historic properties. Paving the area's access road, which ties into the Grand Loop Road, would not be an adverse effect the Grand Loop Road Historic District as there are currently dozens of paved access roads connecting to the district. There are no known archaeological resources within the area of potential effect. WY SHPO concurred Feb 20, 2025.

USFWS concurred with YNP's determination that the Project 'may affect but is not likely to adversely affect the Canada lynx, and the grizzly bear, is 'not likely to jeopardize the continued existence of the monarch butterfly and the Suckleys cuckoo bumble bee, would have 'no effect on the North American wolverine, the yellow-billed cuckoo, and the Ute ladies-tresses, and 'would not destroy or adversely modify designated Canada lynx critical habitat. The Services biological opinion states that the Project is not likely to jeopardize the continued existence of the whitebark pine with the incorporation of conservation measures. The anticipated level of whitebark pine removal caused by the proposed action would not appreciably reduce the overall population, reproduction, and distribution of whitebark pine throughout its range. See attachments within Other Compliance.

Certifications/Permitting:

The Environmental Protection Agency is the only valid certification authority for water quality. All necessary and required certifications (CWA 401, 402) and permits (CWA 404) must be in place before commencement of the activities described in this categorical exclusion.

Area of potential effects (as defined in 36 CFR 800.16[d])

APE map approved by Kyle Stone via email to Alicia Murphy. Includes accurate area for utility upgrades.

3. Has the area of potential effects been surveyed to identify historic properties?

 No

 X Yes

Source or reference:

4. Potentially Affected Resource(s):

Archeological Resources Present: No

Archeological Resources Notes: The park completed five pedestrian survey-based cultural resources inventory in the Canyon residential area between 1989 and 2016. Archaeological inventory efforts identified one archaeological site within 50 ft (15 m) of the APE and none within the APE. Segment D of the former alignment of the Chittenden Road, archeological site 48YE0826, crosses the Grand Loop Road (48YE520) approximately 30 ft. (9.1 m) south of the north junction of the Canyon Government Area Road and the Grand Loop Road (48YE520), Canyon Village to Tower Village section, at the eastern terminus of the APE. Segment D of the Chittenden Road (48YE826) within the Canyon Village Government Residential Area was recommended as not likely eligible for listing on nor contributing to the potential eligibility of the Chittenden Road corridor for listing on the National Register of Historic Places (Sanders et al [1995]). This segment of the Chittenden Road is south of the APE and would not be impacted by the proposed housing construction project.

Historical Structures/Resources Present: Yes

Historical Structures/Resources Notes: Existing unpaved access road that ties into the Grand Loop Rd Historic District (48YE520) will be paved.

Cultural Landscapes Present:

Ethnographic Resources Present: No

Ethnographic Resources Notes: Tribes have identified all of YNP as containing ethnographic resources, however, none specific to this APE have been identified.

5. The proposed action will: (check as many as apply)

 No Destroy, remove, or alter features/elements from a historic structure

 No Replace historic features/elements in kind

 No Add non-historic features/elements to a historic structure

 Yes Alter or remove features/elements of a historic setting or environment (inc. terrain)

 No Add non-historic features/elements (inc. visual, audible, or atmospheric) to a historic setting or cultural landscape

 No Disturb, destroy, or make archeological resources inaccessible

 No Disturb, destroy, or make ethnographic resources inaccessible

☐ **Yes** Potentially affect presently unidentified cultural resources

☐ Begin or contribute to deterioration of historic features, terrain, setting, landscape elements, or archeological or ethnographic resources

☐ **No** Involve a real property transaction (exchange, sale, or lease of land or structures)

☐ Other (please specify): _____

6. Supporting Study Data:

(Attach if feasible; if action is in a plan, EA or EIS, give name and project or page number.)

Culpin, Mary [1994] The History of the Construction of the Road System in Yellowstone National Park, 1872-1966, Historic Resource Study, Volume 1

B. REVIEWS BY CULTURAL RESOURCE SPECIALISTS

The park 106 coordinator requested review by the park's cultural resource specialist/advisors as indicated by check-off boxes or as follows:

No Reviews From: Curator, Archeologist, Historical Architect, Historian, 106 Advisor, Other Advisor, Anthropologist, Historical Landscape Architect

C. PARK SECTION 106 COORDINATOR'S REVIEW AND RECOMMENDATIONS

1. Assessment of Effect:

☐ No Potential to Cause Effects
☐ No Historic Properties Affected
☒ No Adverse Effect
☐ Adverse Effect

2. Documentation Method:

☒ **Standard 36 CFR Part 800 Consultation**

Further consultation under 36 CFR Part 800 is needed.

☐ **Streamlined Review Under the 2008 Servicewide Programmatic Agreement (PA)**

The above action meets all conditions for a streamlined review under section III of the 2008 Servicewide PA for Section 106 compliance.

☐ **Program Comment on Stewardship and Management of National Park Service Mission 66-Era Facilities (1945-1972)**

The above action meets all of the requirements of this Program Comment for Section 106 compliance and required documents have been uploaded.

☐ **Undertaking Related to Park Specific or Another Agreement**

The proposed undertaking is covered for Section 106 purposes under another document such as a park, region or statewide agreement established in accord with 36 CFR 800.7 or 36 CFR 800.14.

3. Consultation Information

SHPO Required: Yes
SHPO Sent: Feb 18, 2025
SHPO Received: Feb 20, 2025

THPO Required:
THPO Sent:
THPO Received:

SHPO/THPO Notes: Concur with finding of no adverse effect.

Advisory Council Participating: No
Advisory Council Notes:
Additional Consulting Parties: No

4. Stipulations and Conditions: Following are listed any stipulations or conditions necessary to ensure that the assessment of effect above is consistent with 36 CFR Part 800 criteria of effect or to avoid or reduce potential adverse effects.

5. Mitigations/Treatment Measures: Measures to prevent or minimize loss or impairment of historic/prehistoric properties: (Remember that setting, location, and use may be relevant.)

Required Mitigations - For the proposed project actions to be within compliance requirements during construction and/or project implementation, the following mitigations must be adhered to:

- All wetlands within or adjacent to project areas must be avoided. Wetlands to be avoided will be marked on the maps/plans provided to construction contractor and flagged prior to start of work. Contact YNP Vegetation Program to schedule flagging.
- The Environmental Protection Agency is the only valid certification authority for water quality. All necessary and required certifications (CWA 401, 402) and permits (CWA 404) must be in place before commencement of the activities described in this categorical exclusion.
- UTE LADIES'-TRESSES Conservation Measures: • Herbicide spot treatments for infrastructure activities will maintain a minimum distance of 1 m (3.3 ft) from Ute ladies-tresses. Ground-based broadcast applications will maintain a minimum distance of 3 m (10 ft) from Ute Ladies-tresses. • Train project personnel to identify the species to ensure project activities do not result in more adverse effects than described in the project description. • Limit soil disturbance and compaction by limiting the use of mechanical equipment such as heavy equipment and vehicles. Control runoff of soil during project activities and avoid using machinery in wet soils and areas prone to ruts. • Minimize creation of dust when using mechanical equipment (heavy equipment and vehicles).
- YELLOW-BILLED CUCKOO: • Managers will ensure all participants, including collaborators, and volunteers, are given orientations on how to avoid disturbing or encountering a yellow-billed cuckoo and other wildlife, including regulations regarding vehicle speed limits, food storage, disposal of garbage and other attractants, and approaching or harassing wildlife. • When possible, managers will limit employee camps and equipment storage areas to existing support facilities to reduce disturbance. • Any observation of a yellow-billed cuckoo within the proposed action area would be reported to the wildlife biologist and appropriate action would be taken to reduce potential effects.
- GRIZZLY BEAR Conservation Measures: • Managers will ensure all participants, including contractors, collaborators, and volunteers, are given orientations on how to avoid disturbing or encountering bears and other wildlife, including regulations regarding vehicle speed limits, food storage, disposal of garbage and other attractants, and approaching or harassing wildlife. • Unless authorized, workers in YNP will avoid designated closure areas that have high historic use by grizzly bears during spring and summer, as well as closure areas around active bear dens to minimize wildlife disturbance and human-wildlife interactions. • When possible, managers will limit employee or contractor camps and equipment storage areas to existing support facilities to reduce disturbance. • During and after management activities, managers will take prevention and restoration measures to avoid the introduction of exotic invasive species and discourage

the

establishment of herbaceous foods such as clover.

- CANADA LYNX Conservation Measures: • Managers will ensure all participants, including contractors, collaborators, and volunteers, are given orientations on how to avoid disturbing, approaching, or harassing lynx and other wildlife. • When possible, managers will limit employee or contractor camps and equipment storage areas to existing support facilities to reduce disturbance. • Any observation of Canada lynx within the action area would be reported to the wildlife biologist and appropriate action would be taken to reduce potential effects.
- WHITEBARK PINE Conservation Measures: • Conduct pre-project surveys to identify WBP individuals of all age classes. • When marking is appropriate, clusters of whitebark pine trees will be marked (so they may be avoided) in a manner that does not cause damage to the tree or introduce disease. • Avoid ground disturbance from heavy equipment within whitebark pine stands and within 10 m (33 ft) of known whitebark pine trees, which will protect the roots and soil within the drip line of large, mature trees. • If using heavy equipment in whitebark pine stands cannot be avoided, equipment will be used sparingly and will be cleaned before entering and leaving work sites to prevent the spread of invasive species, pathogens, and pests. • Avoid off road motorized travel in whitebark pine habitat. • When working in whitebark pine stands, ensure work does not introduce or spread Ribes species that are an alternate host for white pine blister rust. • Herbicide spot treatments for infrastructure activities will maintain a minimum distance of 1 m (3.3 ft) from a whitebark pine tree. Ground-based broadcast applications will maintain a minimum distance of 3 m (10 ft) from the trunk of a whitebark pine tree. • Train project personnel to identify the species regardless of their age class (seedling, sapling, and mature trees) to ensure project activities do not result in more adverse effects than described in the project description. • Wherever possible, avoid removing or damaging healthy, unsuppressed whitebark trees. Limit soil disturbance and compaction by limiting the use of mechanical equipment such as heavy equipment and vehicles. Control runoff of soil during project activities and avoid using machinery in wet soils and areas prone to ruts. • Minimize creation of dust when using mechanical equipment (heavy equipment and vehicles).
- SUCKLEY'S CUCKOO BUMBLE BEE Conservation Measures: • To the extent feasible, no nectar feeding plants or host plant species for Suckleys cuckoo bumble bee will be removed during management activities. • If habitat disturbance is necessary, project managers will try to adjust the timing of activities in areas containing plants used by Suckleys cuckoo bumble bee to avoid interfering with breeding or feeding. • To the extent feasible, managers will avoid using pesticides or herbicides in Suckleys cuckoo bumble bee habitat that could result in direct mortality or eliminate host and nectar plants. • If pesticide application is necessary near Suckleys cuckoo bumble bee habitat, managers will select chemical formulations specific to the targeted pest, time applications to avoid activity periods, establish buffers, and minimize drift to non-target areas by direct ground application.
- MONARCH BUTTERFLY Conservation Measures: • To the extent feasible, no nectar feeding plants or host plant species for monarch butterflies or caterpillars will be removed during management activities.
 - If habitat disturbance is necessary, project managers will try to adjust the timing of activities in areas containing plants used by monarchs to avoid interfering with breeding or feeding.
 - To the extent feasible, managers will avoid using pesticides or herbicides in monarch butterfly habitat that could result in direct mortality or eliminate host and nectar plants.
 - If pesticide application is necessary near monarch butterfly habitat, managers will select chemical formulations specific to the targeted pest, time applications to avoid monarch activity periods, establish buffers, and minimize drift to non-target areas by direct ground application.
- WOLVERINE Conservation Measures: • Managers will ensure all participants, including contractors, collaborators, and volunteers, are given orientations on how to avoid disturbing or encountering wolverines and other wildlife, including regulations regarding vehicle speed limits, food storage, disposal of garbage and other attractants, and approaching or harassing wildlife.
 - When possible, managers will limit employee or contractor camps and equipment storage areas to existing support facilities to reduce disturbance.

- Any observation of wolverines within the proposed action area would be reported to the wildlife biologist and appropriate action would be taken to reduce potential effects.
- All equipment and tools shall be cleaned completely prior to entering the work zone to prevent the spreading of non-invasive plant seeds. Equipment shall be inspected for compliance. (This General Conservation Measure was specified in USFWS Biological Opinion).
- All erosion and sediment control devices shall be adequately maintained to assure continued performance of their intended function. Those that have sustained damage or have reached their capability shall be replaced or maintenance performed. (This General Conservation Measure was specified in USFWS Biological Opinion).
- All material brought into the park from outside sources must be certified weed-free fill obtained from a recently certified facility. Please contact the Yellowstone Center for Resources (YCR) for the most up to date list of certified facilities in the GYE. (This General Conservation Measure was specified in USFWS Biological Opinion).
- Ground disturbance from heavy equipment will be avoided within whitebark pine stands and within 10 meters (m; 33 feet) of known whitebark pine trees, which will protect the roots and soil within the drip line of large, mature trees. (This Whitebark Pine Conservation Measure was specified in USFWS Biological Opinion).
- When marking is appropriate, clusters of whitebark pine trees will be marked (for avoidance) in a manner that does not cause damage to the tree or introduce disease. (This Whitebark Pine Conservation Measure was specified in USFWS Biological Opinion).
- Off road motorized travel in whitebark pine habitat will be avoided. (This Whitebark Pine Conservation Measure was specified in USFWS Biological Opinion).
- Train project personnel to identify the species regardless of their age class (seedling, sapling, and mature trees) to ensure project activities do not result in more adverse effects than described in the project description. (This Whitebark Pine Conservation Measure was specified in USFWS Biological Opinion).
- Wherever possible, avoid removing or damaging healthy, unsuppressed whitebark trees. Limit soil disturbance and compaction by limiting the use of mechanical equipment such as heavy equipment and vehicles. Control runoff of soil during project activities and avoid using machinery in wet soils and areas prone to ruts. (This Whitebark Pine Conservation Measure was specified in USFWS Biological Opinion).
- Herbicide spot treatments for infrastructure activities will maintain a minimum distance of 1 m (3.3 feet) from a whitebark pine tree. Ground-based broadcast applications will maintain a minimum distance of 3 m (10 feet) from the trunk of a whitebark pine tree. (This Whitebark Pine Conservation Measure was specified in USFWS Biological Opinion).
- Ensure work crews adhere to bear safety and food storage regulations.
- The project lead will ensure that all project-related employees, such as contract employees, would be given orientation on how to avoid disturbing or encountering bears and how to minimize unavoidable effects or encounters. Orientation would include information about park regulations regarding food storage, disposal of garbage and other bear attractants, and approaching or harassing wildlife.
- If using heavy equipment in whitebark pine stands cannot be avoided, equipment will be used sparingly and will be cleaned before entering and leaving work sites to prevent the spread of invasive species, pathogens, and pests. (This Whitebark Pine Conservation Measure was specified in USFWS Biological Opinion).
- Pre-project surveys will be conducted to identify whitebark pine individuals of all age classes. (This Whitebark Pine Conservation Measure was specified in USFWS Biological Opinion).
- When working in whitebark pine stands, work will not introduce or spread *Ribes* species that are an alternate host for white pine blister rust. (This Whitebark Pine Conservation Measure was specified in USFWS Biological Opinion).
- All workers will be informed of the criminal penalties for illegally collecting historic objects and/or artifacts or intentionally damaging any archeological or historic property. Workers will also be informed of the correct procedures should cultural resources be uncovered during construction activities. Cultural resources will be identified and documented by a professional archaeologist, historian, or museum curator (as appropriate) that meets SOI and NPS standards, and an appropriate mitigation strategy will be developed, if necessary, in accordance with pertinent laws and regulations, including the stipulations of the 2008 Programmatic Agreement Among the National Park Service (U.S. Department of the Interior),

the Advisory Council on Historic Preservation, and the National Conference of State Historic Preservation Officers.

- If previously unknown archeological resources are discovered during construction activities, all ground disturbing activities in the immediate vicinity (300 feet) of the discovery shall be halted and the Park Archaeologist notified immediately. Cultural resources will be identified and documented by an archaeologist meeting the NPS Qualification Standards and the Secretary of the Interior's Professional Qualification Standards. An appropriate mitigation strategy will be developed, if necessary, in accordance with pertinent laws and regulations.
- In the event that human remains or other items that fall under the purview of NAGPRA are discovered during construction activities, all work on the project must stop and the park archeologist contacted immediately. As required by law, the coroner will be notified first. All provisions outlined in the Native American Graves Protection and Repatriation Act (1990) will be followed.
- Project will ensure vegetation continues to screen views of development (such as the NPS government areas) from the Grand Loop Road Historic District (48YE520) by retaining trees of varied maturation that provide both understory and canopy trees.
- To avoid impacts to migratory birds during nesting season, please consider conducting all vegetation removal activities outside of March 1 - August 15th for raptors, and May 1 - August 15th for songbirds. If you are within the March 1 - August 15 window, and you suspect active nests from detection of physical structures (e.g. large collections of sticks or smaller plant material in nest-like shape, cavity holes) or behaviors (e.g. birds in and out of tree cavities, activity at nest-like structures in trees, birds carrying food into nest-like structures), please contact the Bird Program Manager at 307-344-2218 or david_b_haines@nps.gov to discuss or schedule a survey.
- To minimize the amount of ground disturbance, staging and stockpiling areas shall be located in previously disturbed sites, away from visitor use areas to the greatest extent possible. All staging and stockpiling areas shall be returned to pre-construction conditions following construction.
- To the extent practical, work shall be scheduled to avoid construction activity and construction related delays during peak visitation times. No holiday or night time work shall be allowed. Weekend work (Friday through Sunday) shall not be allowed unless authorized in writing by the park's Superintendent.
- Project manager will ensure residents are properly notified of project related activities including closures, detours, power outages, and invasive plant treatment as necessary, prior to commencement of the aforementioned activities.
- Contractors would coordinate with park staff to reduce disruption in normal park activities (i.e. facilitate emergency traffic, and hauling material, to allow for visitor use in areas where no conflicts or safety concerns exist).
- To minimize the amount of ground disturbance, staging and stockpiling areas would be located in previously disturbed sites if at all possible. All staging and stockpiling areas would be returned to pre-construction conditions following construction. Construction zones and staging areas would be identified and fenced with construction tape, snow fencing, or some similar material prior to any construction activity. The fencing would define the construction zone and confine activity to the minimum area required for construction.
- Please contact your compliance representative if the scope of work changes to ensure proper compliance documentation has been completed. Upon project completion, please send a written summary, with photos if possible, to close out the administrative record for your project.
- Project shall comply with NPS and park lighting guidelines to reduce impacts to the night sky and wildlife. This will include, but is not limited to, low-level lighting, minimized glare, downward focused light fixtures, and energy efficient light sources such as low-pressure sodium lamps.
- Line locates must be completed before any excavation work may begin. The depth of utility line varies and there may be multiple utility lines in a common area. Digging without calling can disrupt service, harm you and those around you and potentially result in fines and repair costs. Calling 811 before every job gets underground utility lines marked for free and helps prevent undesired consequences.
- Any and all historic objects discovered during this project (i.e. under foundations, in wall, attic, or crawl spaces, etc.) remain property of the federal government and shall be considered by the YELL Collections Committee for accessioning into the park unit's museum collection whether they are stored at an NPS facility or placed on loan to an agreed upon repository.

- The project lead will ensure that all project-related employees, such as contract employees, would be given orientation on how to avoid disturbing or encountering bears and how to minimize unavoidable effects or encounters. Orientation would include information about park regulations regarding food storage, disposal of garbage and other bear attractants, and approaching or harassing wildlife.
- Ensure work crews adhere to bear safety and food storage regulations.

6. Assessment of Effect Notes:

D. RECOMMENDED BY PARK SECTION 106 COORDINATOR:

E. SUPERINTENDENT'S APPROVAL

The proposed work conforms to the NPS *Management Policies* and *Cultural Resource Management Guideline*, and I have reviewed and approve the recommendations, stipulations, or conditions noted in Section C of this form.



Other Compliance/Consultations Form

Park Name: Yellowstone National Park
PEPC Project Number: 121583
Project Title: Canyon Ballfield Modulars (Goal I Housing)
Project Type: Capital Improvement/New Construction
Project Location:
County, State: Park, WY
Project Leader: Robert Kammel

ESA

Any Federal Species in the project Area? Yes

If species in area: Likely to Adversely Affect

Was Biological Assessment prepared? Yes

Sent to FWS: Apr 28, 2025

FWS Response: May 23, 2025

Sent to NMFS:

NMFS Response:

If Biological Assessment prepared, concurred? Yes

Formal Consultation required? Yes

Formal Consultation Notes:

The Services biological opinion states that the Project is not likely to jeopardize the continued existence of the whitebark pine with the incorporation of conservation measures. The anticipated level of whitebark pine removal caused by the proposed action will not appreciably reduce the overall population, reproduction, and distribution of whitebark pine throughout its range.

Formal Consultation Concluded:

May 23, 2025

Any State listed Species in the Project Area?

Consultation Information:

USFWS concurred with YNP's determination that the Project 'may affect but is not likely to adversely affect the Canada lynx, (*Lynx canadensis*) and the grizzly bear (*Ursus arctos*), is 'not likely to jeopardize the continued existence of the monarch butterfly (*Danaus plexippus*) and the Suckleys cuckoo bumble bee (*Bombus suckleyi*), will have 'no effect on the North American wolverine (*Gulo gulo luscus*), the yellow-billed cuckoo (*Coccyzus americanus*), and the Ute ladies-tresses (*Spiranthes diluvialis*), and 'will not destroy or adversely modify designated Canada lynx critical habitat.

General Notes:

Data Entered By: Daniel Stahler

Date: Sep 16, 2025

ESA Mitigations

Mitigation ID	Type	Text
189934	Rare, Threatened & Endangered Species	WOLVERINE Conservation Measures: • Managers will ensure all participants, including contractors, collaborators, and volunteers, are given orientations on how to avoid disturbing or encountering wolverines and other wildlife, including regulations regarding vehicle speed limits, food storage, disposal of garbage and other attractants, and approaching or harassing wildlife. • When possible, managers will limit employee or contractor camps and equipment storage areas to existing support facilities to reduce disturbance. • Any observation of wolverines within the proposed action area would be reported to the wildlife biologist and appropriate action would be taken to reduce potential effects.
175896	Rare, Threatened & Endangered Species	Ensure work crews adhere to bear safety and food storage regulations.
175897	Rare, Threatened & Endangered Species	The project lead will ensure that all project-related employees, such as contract employees, would be given orientation on how to avoid disturbing or encountering bears and how to minimize unavoidable effects or encounters. Orientation would include information about park regulations regarding food storage, disposal of garbage and other bear attractants, and approaching or harassing wildlife.
189794	Rare, Threatened & Endangered Species	When working in whitebark pine stands, work will not introduce or spread Ribes species that are an alternate host for white pine blister rust. (This Whitebark Pine Conservation Measure was specified in USFWS Biological Opinion).
189803	Rare, Threatened & Endangered Species	When marking is appropriate, clusters of whitebark pine trees will be marked (for avoidance) in a manner that does not cause damage to the tree or introduce disease. (This Whitebark Pine Conservation Measure was specified in USFWS Biological Opinion).
189804	Rare, Threatened & Endangered Species	Ground disturbance from heavy equipment will be avoided within whitebark pine stands and within 10 meters (m; 33 feet) of known whitebark pine trees, which will protect the roots and soil within the drip line of large, mature trees. (This Whitebark Pine Conservation Measure was specified in USFWS Biological Opinion).
189937	Rare, Threatened & Endangered Species	WHITEBARK PINE Conservation Measures: • Conduct pre-project surveys to identify WBP individuals of all age classes. • When marking is appropriate, clusters of whitebark pine trees will be marked (so they may be avoided) in a manner that does not cause damage to the tree or introduce disease. • Avoid ground disturbance from heavy equipment within whitebark pine stands and within 10 m (33 ft) of known whitebark pine trees, which will protect the roots and soil within the drip line of large, mature trees. • If using heavy equipment in whitebark pine stands cannot be avoided, equipment will be used sparingly and will be cleaned before entering and leaving work sites to prevent the spread of invasive species, pathogens, and pests. • Avoid off road motorized travel in whitebark pine habitat. • When working in whitebark pine stands, ensure work does not introduce or spread Ribes species that are an alternate host for white pine blister rust. • Herbicide spot treatments for infrastructure activities will maintain a minimum distance of 1 m (3.3 ft) from a whitebark pine tree. Ground-based broadcast applications will maintain a minimum distance of 3 m (10 ft) from the trunk of a whitebark pine tree. • Train project personnel to identify the species regardless of their age class (seedling, sapling, and mature trees) to ensure project activities do not result in more adverse effects than described in the project description. • Wherever possible, avoid removing or damaging healthy, unsuppressed whitebark trees. Limit soil disturbance and compaction by limiting the use of mechanical equipment such as heavy equipment and vehicles. Control runoff of soil during project activities and avoid using machinery in wet soils and areas prone to ruts. • Minimize creation of dust when using mechanical equipment (heavy equipment and vehicles).

Mitigation ID	Type	Text
189938	Rare, Threatened & Endangered Species	CANADA LYNX Conservation Measures: • Managers will ensure all participants, including contractors, collaborators, and volunteers, are given orientations on how to avoid disturbing, approaching, or harassing lynx and other wildlife. • When possible, managers will limit employee or contractor camps and equipment storage areas to existing support facilities to reduce disturbance. • Any observation of Canada lynx within the action area would be reported to the wildlife biologist and appropriate action would be taken to reduce potential effects.
189940	Rare, Threatened & Endangered Species	YELLOW-BILLED CUCKOO: • Managers will ensure all participants, including collaborators, and volunteers, are given orientations on how to avoid disturbing or encountering a yellow-billed cuckoo and other wildlife, including regulations regarding vehicle speed limits, food storage, disposal of garbage and other attractants, and approaching or harassing wildlife. • When possible, managers will limit employee camps and equipment storage areas to existing support facilities to reduce disturbance. • Any observation of a yellow-billed cuckoo within the proposed action area would be reported to the wildlife biologist and appropriate action would be taken to reduce potential effects.
189941	Rare, Threatened & Endangered Species	UTE LADIES'-TRESSES Conservation Measures: • Herbicide spot treatments for infrastructure activities will maintain a minimum distance of 1 m (3.3 ft) from Ute ladies-tresses. Ground-based broadcast applications will maintain a minimum distance of 3 m (10 ft) from Ute Ladies-tresses. • Train project personnel to identify the species to ensure project activities do not result in more adverse effects than described in the project description. • Limit soil disturbance and compaction by limiting the use of mechanical equipment such as heavy equipment and vehicles. Control runoff of soil during project activities and avoid using machinery in wet soils and areas prone to ruts. • Minimize creation of dust when using mechanical equipment (heavy equipment and vehicles).
189935	Rare, Threatened & Endangered Species	MONARCH BUTTERFLY Conservation Measures: • To the extent feasible, no nectar feeding plants or host plant species for monarch butterflies or caterpillars will be removed during management activities. • If habitat disturbance is necessary, project managers will try to adjust the timing of activities in areas containing plants used by monarchs to avoid interfering with breeding or feeding. • To the extent feasible, managers will avoid using pesticides or herbicides in monarch butterfly habitat that could result in direct mortality or eliminate host and nectar plants. • If pesticide application is necessary near monarch butterfly habitat, managers will select chemical formulations specific to the targeted pest, time applications to avoid monarch activity periods, establish buffers, and minimize drift to non-target areas by direct ground application.
189936	Rare, Threatened & Endangered Species	SUCKLEY'S CUCKOO BUMBLE BEE Conservation Measures: • To the extent feasible, no nectar feeding plants or host plant species for Suckleys cuckoo bumble bee will be removed during management activities. • If habitat disturbance is necessary, project managers will try to adjust the timing of activities in areas containing plants used by Suckleys cuckoo bumble bee to avoid interfering with breeding or feeding. • To the extent feasible, managers will avoid using pesticides or herbicides in Suckleys cuckoo bumble bee habitat that could result in direct mortality or eliminate host and nectar plants. • If pesticide application is necessary near Suckleys cuckoo bumble bee habitat, managers will select chemical formulations specific to the targeted pest, time applications to avoid activity periods, establish buffers, and minimize drift to non-target areas by direct ground application.
189939	Rare, Threatened & Endangered Species	GRIZZLY BEAR Conservation Measures: • Managers will ensure all participants, including contractors, collaborators, and volunteers, are given orientations on how to avoid disturbing or encountering bears and other wildlife, including regulations regarding vehicle speed limits, food storage, disposal of garbage and other attractants, and approaching or harassing wildlife. • Unless authorized, workers in YNP will avoid designated closure areas that have high historic use by grizzly bears during spring and summer, as well as closure areas around

Mitigation ID	Type	Text
		active bear dens to minimize wildlife disturbance and human-wildlife interactions. • When possible, managers will limit employee or contractor camps and equipment storage areas to existing support facilities to reduce disturbance. • During and after management activities, managers will take prevention and restoration measures to avoid the introduction of exotic invasive species and discourage the establishment of herbaceous foods such as clover.
189795	Rare, Threatened & Endangered Species	Pre-project surveys will be conducted to identify whitebark pine individuals of all age classes. (This Whitebark Pine Conservation Measure was specified in USFWS Biological Opinion).
189796	Rare, Threatened & Endangered Species	If using heavy equipment in whitebark pine stands cannot be avoided, equipment will be used sparingly and will be cleaned before entering and leaving work sites to prevent the spread of invasive species, pathogens, and pests. (This Whitebark Pine Conservation Measure was specified in USFWS Biological Opinion).
189797	Rare, Threatened & Endangered Species	The project lead will ensure that all project-related employees, such as contract employees, would be given orientation on how to avoid disturbing or encountering bears and how to minimize unavoidable effects or encounters. Orientation would include information about park regulations regarding food storage, disposal of garbage and other bear attractants, and approaching or harassing wildlife.
189798	Rare, Threatened & Endangered Species	Ensure work crews adhere to bear safety and food storage regulations.
189799	Rare, Threatened & Endangered Species	Herbicide spot treatments for infrastructure activities will maintain a minimum distance of 1 m (3.3 feet) from a whitebark pine tree. Ground-based broadcast applications will maintain a minimum distance of 3 m (10 feet) from the trunk of a whitebark pine tree. (This Whitebark Pine Conservation Measure was specified in USFWS Biological Opinion).
189800	Rare, Threatened & Endangered Species	Wherever possible, avoid removing or damaging healthy, unsuppressed whitebark trees. Limit soil disturbance and compaction by limiting the use of mechanical equipment such as heavy equipment and vehicles. Control runoff of soil during project activities and avoid using machinery in wet soils and areas prone to ruts. (This Whitebark Pine Conservation Measure was specified in USFWS Biological Opinion).
189801	Rare, Threatened & Endangered Species	Train project personnel to identify the species regardless of their age class (seedling, sapling, and mature trees) to ensure project activities do not result in more adverse effects than described in the project description. (This Whitebark Pine Conservation Measure was specified in USFWS Biological Opinion).
189802	Rare, Threatened & Endangered Species	Off road motorized travel in whitebark pine habitat will be avoided. (This Whitebark Pine Conservation Measure was specified in USFWS Biological Opinion).

Floodplains/Wetlands/§404 Permits

Question	Yes	No	Details
A.1. Is project in 100- or 500-year floodplain or flash flood hazard area?		No	Not in floodplain or flash flood hazard area.
A.2. Is Project in wetlands as	Yes		Determined to be exempt from compliance with Director's Order #77-1 and no Wetland Statement of Findings required.

defined by NPS/DOI?			
B. COE Section 404 permit needed?	Yes		Request Date: Issue Date: Expiration Date:
C. State 401 certification?		No	
D. State Section 401 Permit?		No	Issue Date: Expiration Date:
E. Tribal Water Quality Permit?		No	
F. CZM Consistency determination needed?			N/A
G. Erosion & Sediment Control Plan Required?		No	
H. Any other permits required?		No	Permit Information:
Other Information:			- See attached wetland delineations. - The proposed action would permanently impact 0.033 acres (48.29 cu yd) of roadside ditch wetlands. Construction would temporarily impact 0.001 ac (4.87 cu yd) roadside ditch wetlands. The project design was not able to avoid these impacts since the road is existing and there are wetlands on the on the other side of the road as well. - NO WETLAND STATEMENT OF FINDING required per listed exemptions (see attached email correspondence). The proposed action would widen the existing road but would not add lanes or capacity. The action would renovate the existing road. It would likely reduce the impact to the roadside ditch wetlands since vehicles would not be driving through dirt/mud creating muddy runoff into the wetland. - The Environmental Protection Agency is the only valid certification authority for water quality. All necessary and required certifications (CWA 401, 402) and permits (CWA 404) must be in place before commencement of the activities described in this categorical exclusion.

Data Entered By: Bonnie Mcdonald Date: _____

FloodPlains & Wetlands Mitigations

Mitigation ID	Type	Text
175900	Floodplains & Wetlands	All wetlands within or adjacent to project areas must be avoided. Wetlands to be avoided will be marked on the maps/plans provided to construction contractor and flagged prior to start of work. Contact YNP Vegetation Program to schedule flagging.

Mitigation ID	Type	Text
189925	Floodplains & Wetlands	The Environmental Protection Agency is the only valid certification authority for water quality. All necessary and required certifications (CWA 401, 402) and permits (CWA 404) must be in place before commencement of the activities described in this categorical exclusion.

Notes: All wetlands within or adjacent to project areas must be avoided. Wetlands to be avoided will be marked on the maps/plans provided to construction contractor and flagged prior to start of work. Contact YNP Vegetation Program to schedule flagging.

Wilderness

Question	Yes	No	
A. Does this project occur in or adjacent to Designated, Recommended, Proposed, Study, Eligible, or Potential Wilderness?		No	
B. Is the only place to conduct this project in wilderness?		No	
C. Is the project necessary for the administration of the area as wilderness?		No	
D. Would the project or any of its alternatives adversely affect (directly or indirectly) Designated, Recommended, Proposed, Study, Eligible, or Potential Wilderness? (If Yes, Minimum Requirements Analysis required)		No	
E. Does the project or any of its alternatives involve the use of any of the Wilderness Act Section 4(c) prohibited uses: commercial enterprise, permanent road, temporary road, motor vehicles, motorized equipment, motorboats, landing of aircraft, mechanical transport, structure, or installation? (If Yes, Minimum Requirements Analysis required)		No	
If the answer to D or E above is "Yes" then a Minimum Requirements Analysis is required. Describe the status of this analysis in the column to the right.			Initiation Date: Completed Date: Approved Date:
Other Information:			

Data Entered By: Bonnie Mcdonald **Date:** Aug 7, 2025

Other Permits/Laws Questions A & B are no longer used.

Question	Yes	No
C. Wild and scenic river concerns exist?		No
D. National Trails concerns exist?		No

E. Air Quality consult with State needed?		No
F. Consistent with Architectural Barriers, Rehabilitation, and Americans with Disabilities Acts or not Applicable? (If N/A check Yes)	Yes	
G. Other:		No

Other Information:

Data Entered By: Bonnie Mcdonald **Date:** Aug 7, 2025



Mitigations List Form

Date: Sep 16, 2025

Park: Yellowstone National Park

Project: Canyon Ballfield Modulares (Goal I Housing)

PEPC Project Number: 121583

Project Description:

Yellowstone National Park (YNP) is located in a remote area, mostly surrounded by publicly-owned land. Housing costs in Gardiner and the surrounding area have risen sharply in recent years, with the average home price in Gardiner being in the \$850,000 range. Consequently, few of the park's employees can afford to live outside the park. Housing inside the park is scarce and often in poor condition, although YNP is in the midst of a multi-year effort to improve existing housing. However, the park does not contain enough housing to accommodate the year-round employees necessary for park operations. The housing shortage has negatively impacted YNP's ability to attract qualified employees to fill permanent positions. As a result, YNP is proposing to increase employee housing units in a variety of locations and configurations, including in the Canyon administrative area.

Yellowstone National Park proposes to install 10 modular employee housing units along the existing Canyon Government Area Road/Badger Road. The area is currently used as a boneyard for material storage and is situated between existing National Park Service employee housing and office space and a contractor RV park. The proposed residential units would be of modular construction, two-bedroom and two-bathroom, single-family homes with gabled roofs and front porches, installed on concrete foundations. They would be similar in type and construction to other recent housing in YNP. Additionally, the necessary utilities would be installed, and the existing dirt road would be widened and paved. See attached plans.

Temporary staging of construction materials would take place on the project site. The proposed action would be performed by an independent contractor beginning in May 2026.

YNP Cultural Resources staff determined that the proposed project would not have an adverse effect on historic properties. The housing units themselves would not be in view of any historic properties. Paving the area's access road, which ties into the Grand Loop Road, would not be an adverse effect the Grand Loop Road Historic District as there are currently dozens of paved access roads connecting to the district. There are no known archaeological resources within the area of potential effect. WY SHPO concurred Feb 20, 2025.

USFWS concurred with YNP's determination that the Project 'may affect but is not likely to adversely affect the Canada lynx, and the grizzly bear, is 'not likely to jeopardize the continued existence of the monarch butterfly and the Suckleys cuckoo bumble bee, would have 'no effect on the North American wolverine, the yellow-billed cuckoo, and the Ute ladies-tresses, and 'would not destroy or adversely modify designated Canada lynx critical habitat. The Services biological opinion states that the Project is not likely to jeopardize the continued existence of the whitebark pine with the incorporation of conservation measures. The anticipated level of whitebark pine removal caused by the proposed action would not appreciably reduce the overall population, reproduction, and distribution of whitebark pine throughout its range. See attachments within Other Compliance.

Certifications/Permitting:

The Environmental Protection Agency is the only valid certification authority for water quality. All necessary and required certifications (CWA 401, 402) and permits (CWA 404) must be in place before commencement of the activities described in this categorical exclusion.

Project Locations:

Location

County: Park

State: WY

District:

Section:

Geo. Marker:

Other:

Tract ID:

Funding

Source(s):

PMIS

Number(s):

Mitigation(s):

(the following is a complete list of all mitigations that will be incorporated into the above-referenced project)

- Floodplains & Wetlands : All wetlands within or adjacent to project areas must be avoided. Wetlands to be avoided will be marked on the maps/plans provided to construction contractor and flagged prior to start of work. Contact YNP Vegetation Program to schedule flagging.
- Floodplains & Wetlands : The Environmental Protection Agency is the only valid certification authority for water quality. All necessary and required certifications (CWA 401, 402) and permits (CWA 404) must be in place before commencement of the activities described in this categorical exclusion.
- Rare, Threatened & Endangered Species : UTE LADIES'-TRESSES Conservation Measures: • Herbicide spot treatments for infrastructure activities will maintain a minimum distance of 1 m (3.3 ft) from Ute ladies-tresses. Ground-based broadcast applications will maintain a minimum distance of 3 m (10 ft) from Ute Ladies-tresses. • Train project personnel to identify the species to ensure project activities do not result in more adverse effects than described in the project description. • Limit soil disturbance and compaction by limiting the use of mechanical equipment such as heavy equipment and vehicles. Control runoff of soil during project activities and avoid using machinery in wet soils and areas prone to ruts. • Minimize creation of dust when using mechanical equipment (heavy equipment and vehicles).
- Rare, Threatened & Endangered Species : YELLOW-BILLED CUCKOO: • Managers will ensure all participants, including collaborators, and volunteers, are given orientations on how to avoid disturbing or encountering a yellow-billed cuckoo and other wildlife, including regulations regarding vehicle speed limits, food storage, disposal of garbage and other attractants, and approaching or harassing wildlife. • When possible, managers will limit employee camps and equipment storage areas to existing support facilities to reduce disturbance. • Any observation of a yellow-billed cuckoo within the proposed action area would be reported to the wildlife biologist and appropriate action would be taken to reduce potential effects.
- Rare, Threatened & Endangered Species : GRIZZLY BEAR Conservation Measures: • Managers will ensure all participants, including contractors, collaborators, and volunteers, are given orientations on how to avoid disturbing or encountering bears and other wildlife, including regulations regarding vehicle speed limits, food storage, disposal of garbage and other attractants, and approaching or harassing wildlife. • Unless authorized, workers in YNP will avoid designated closure areas that have high historic use by grizzly bears during spring and summer, as well as closure areas around active bear dens to minimize wildlife disturbance and human-wildlife interactions. • When possible, managers will limit employee or contractor camps and equipment storage areas to existing support facilities to reduce disturbance. • During and after management activities, managers will take prevention and restoration measures to avoid the introduction of exotic invasive species and discourage the establishment of herbaceous foods such as clover.
- Rare, Threatened & Endangered Species : CANADA LYNX Conservation Measures: • Managers will ensure all participants, including contractors, collaborators, and volunteers, are given orientations on how to avoid disturbing, approaching, or harassing lynx and other wildlife. • When possible, managers will limit employee or contractor camps and equipment storage areas to existing support facilities to reduce disturbance. • Any observation of Canada lynx within the action area would be reported to the wildlife biologist and appropriate action would be taken to reduce potential effects.

- Rare, Threatened & Endangered Species : WHITEBARK PINE Conservation Measures: • Conduct pre-project surveys to identify WBP individuals of all age classes. • When marking is appropriate, clusters of whitebark pine trees will be marked (so they may be avoided) in a manner that does not cause damage to the tree or introduce disease. • Avoid ground disturbance from heavy equipment within whitebark pine stands and within 10 m (33 ft) of known whitebark pine trees, which will protect the roots and soil within the drip line of large, mature trees. • If using heavy equipment in whitebark pine stands cannot be avoided, equipment will be used sparingly and will be cleaned before entering and leaving work sites to prevent the spread of invasive species, pathogens, and pests. • Avoid off road motorized travel in whitebark pine habitat. • When working in whitebark pine stands, ensure work does not introduce or spread *Ribes* species that are an alternate host for white pine blister rust. • Herbicide spot treatments for infrastructure activities will maintain a minimum distance of 1 m (3.3 ft) from a whitebark pine tree. Ground-based broadcast applications will maintain a minimum distance of 3 m (10 ft) from the trunk of a whitebark pine tree. • Train project personnel to identify the species regardless of their age class (seedling, sapling, and mature trees) to ensure project activities do not result in more adverse effects than described in the project description. • Wherever possible, avoid removing or damaging healthy, unsuppressed whitebark trees. Limit soil disturbance and compaction by limiting the use of mechanical equipment such as heavy equipment and vehicles. Control runoff of soil during project activities and avoid using machinery in wet soils and areas prone to ruts. • Minimize creation of dust when using mechanical equipment (heavy equipment and vehicles).
- Rare, Threatened & Endangered Species : SUCKLEY'S CUCKOO BUMBLE BEE Conservation Measures: • To the extent feasible, no nectar feeding plants or host plant species for Suckleys cuckoo bumble bee will be removed during management activities. • If habitat disturbance is necessary, project managers will try to adjust the timing of activities in areas containing plants used by Suckleys cuckoo bumble bee to avoid interfering with breeding or feeding. • To the extent feasible, managers will avoid using pesticides or herbicides in Suckleys cuckoo bumble bee habitat that could result in direct mortality or eliminate host and nectar plants. • If pesticide application is necessary near Suckleys cuckoo bumble bee habitat, managers will select chemical formulations specific to the targeted pest, time applications to avoid activity periods, establish buffers, and minimize drift to non-target areas by direct ground application.
- Rare, Threatened & Endangered Species : MONARCH BUTTERFLY Conservation Measures: • To the extent feasible, no nectar feeding plants or host plant species for monarch butterflies or caterpillars will be removed during management activities.
 - If habitat disturbance is necessary, project managers will try to adjust the timing of activities in areas containing plants used by monarchs to avoid interfering with breeding or feeding.
 - To the extent feasible, managers will avoid using pesticides or herbicides in monarch butterfly habitat that could result in direct mortality or eliminate host and nectar plants.
 - If pesticide application is necessary near monarch butterfly habitat, managers will select chemical formulations specific to the targeted pest, time applications to avoid monarch activity periods, establish buffers, and minimize drift to non-target areas by direct ground application.
- Rare, Threatened & Endangered Species : WOLVERINE Conservation Measures: • Managers will ensure all participants, including contractors, collaborators, and volunteers, are given orientations on how to avoid disturbing or encountering wolverines and other wildlife, including regulations regarding vehicle speed limits, food storage, disposal of garbage and other attractants, and approaching or harassing wildlife.
 - When possible, managers will limit employee or contractor camps and equipment storage areas to existing support facilities to reduce disturbance.
 - Any observation of wolverines within the proposed action area would be reported to the wildlife biologist and appropriate action would be taken to reduce potential effects.
- Vegetation - Weed/Seed Free : All equipment and tools shall be cleaned completely prior to entering the work zone to prevent the spreading of non-invasive plant seeds. Equipment shall be inspected for compliance. (This General Conservation Measure was specified in USFWS Biological Opinion).
- Soils, Topography, Geology - Erosion Controls : All erosion and sediment control devices shall be adequately maintained to assure continued performance of their intended function. Those that have sustained damage or have reached their capability shall be replaced or maintenance performed. (This General Conservation Measure was specified in USFWS Biological Opinion).

- Other : All material brought into the park from outside sources must be certified weed-free fill obtained from a recently certified facility. Please contact the Yellowstone Center for Resources (YCR) for the most up to date list of certified facilities in the GYE. (This General Conservation Measure was specified in USFWS Biological Opinion).
- Rare, Threatened & Endangered Species : Ground disturbance from heavy equipment will be avoided within whitebark pine stands and within 10 meters (m; 33 feet) of known whitebark pine trees, which will protect the roots and soil within the drip line of large, mature trees. (This Whitebark Pine Conservation Measure was specified in USFWS Biological Opinion).
- Rare, Threatened & Endangered Species : When marking is appropriate, clusters of whitebark pine trees will be marked (for avoidance) in a manner that does not cause damage to the tree or introduce disease. (This Whitebark Pine Conservation Measure was specified in USFWS Biological Opinion).
- Rare, Threatened & Endangered Species : Off road motorized travel in whitebark pine habitat will be avoided. (This Whitebark Pine Conservation Measure was specified in USFWS Biological Opinion).
- Rare, Threatened & Endangered Species : Train project personnel to identify the species regardless of their age class (seedling, sapling, and mature trees) to ensure project activities do not result in more adverse effects than described in the project description. (This Whitebark Pine Conservation Measure was specified in USFWS Biological Opinion).
- Rare, Threatened & Endangered Species : Wherever possible, avoid removing or damaging healthy, unsuppressed whitebark trees. Limit soil disturbance and compaction by limiting the use of mechanical equipment such as heavy equipment and vehicles. Control runoff of soil during project activities and avoid using machinery in wet soils and areas prone to ruts. (This Whitebark Pine Conservation Measure was specified in USFWS Biological Opinion).
- Rare, Threatened & Endangered Species : Herbicide spot treatments for infrastructure activities will maintain a minimum distance of 1 m (3.3 feet) from a whitebark pine tree. Ground-based broadcast applications will maintain a minimum distance of 3 m (10 feet) from the trunk of a whitebark pine tree. (This Whitebark Pine Conservation Measure was specified in USFWS Biological Opinion).
- Rare, Threatened & Endangered Species : Ensure work crews adhere to bear safety and food storage regulations.
- Rare, Threatened & Endangered Species : The project lead will ensure that all project-related employees, such as contract employees, would be given orientation on how to avoid disturbing or encountering bears and how to minimize unavoidable effects or encounters. Orientation would include information about park regulations regarding food storage, disposal of garbage and other bear attractants, and approaching or harassing wildlife.
- Rare, Threatened & Endangered Species : If using heavy equipment in whitebark pine stands cannot be avoided, equipment will be used sparingly and will be cleaned before entering and leaving work sites to prevent the spread of invasive species, pathogens, and pests. (This Whitebark Pine Conservation Measure was specified in USFWS Biological Opinion).
- Rare, Threatened & Endangered Species : Pre-project surveys will be conducted to identify whitebark pine individuals of all age classes. (This Whitebark Pine Conservation Measure was specified in USFWS Biological Opinion).
- Rare, Threatened & Endangered Species : When working in whitebark pine stands, work will not introduce or spread Ribes species that are an alternate host for white pine blister rust. (This Whitebark Pine Conservation Measure was specified in USFWS Biological Opinion).
- Assessment of Effect - Archaeology : All workers will be informed of the criminal penalties for illegally collecting historic objects and/or artifacts or intentionally damaging any archeological or historic property. Workers will also be informed of the correct procedures should cultural resources be uncovered during construction activities. Cultural resources will be identified and documented by a professional archaeologist, historian, or museum curator (as appropriate) that meets SOI and NPS standards, and an appropriate mitigation strategy will be developed, if necessary, in accordance with pertinent laws and regulations, including the stipulations of the 2008 Programmatic Agreement Among the National Park Service (U.S. Department of the Interior), the Advisory Council on Historic Preservation, and the National Conference of State Historic Preservation Officers.
- Assessment of Effect - Archaeology : If previously unknown archeological resources are discovered during construction activities, all ground disturbing activities in the immediate vicinity (300 feet) of the discovery shall be halted and the Park Archaeologist notified immediately. Cultural resources will be identified and documented by an archaeologist meeting the NPS Qualification Standards and the Secretary of the Interior's Professional Qualification Standards. An appropriate mitigation strategy will be developed, if necessary, in accordance with pertinent laws and regulations.

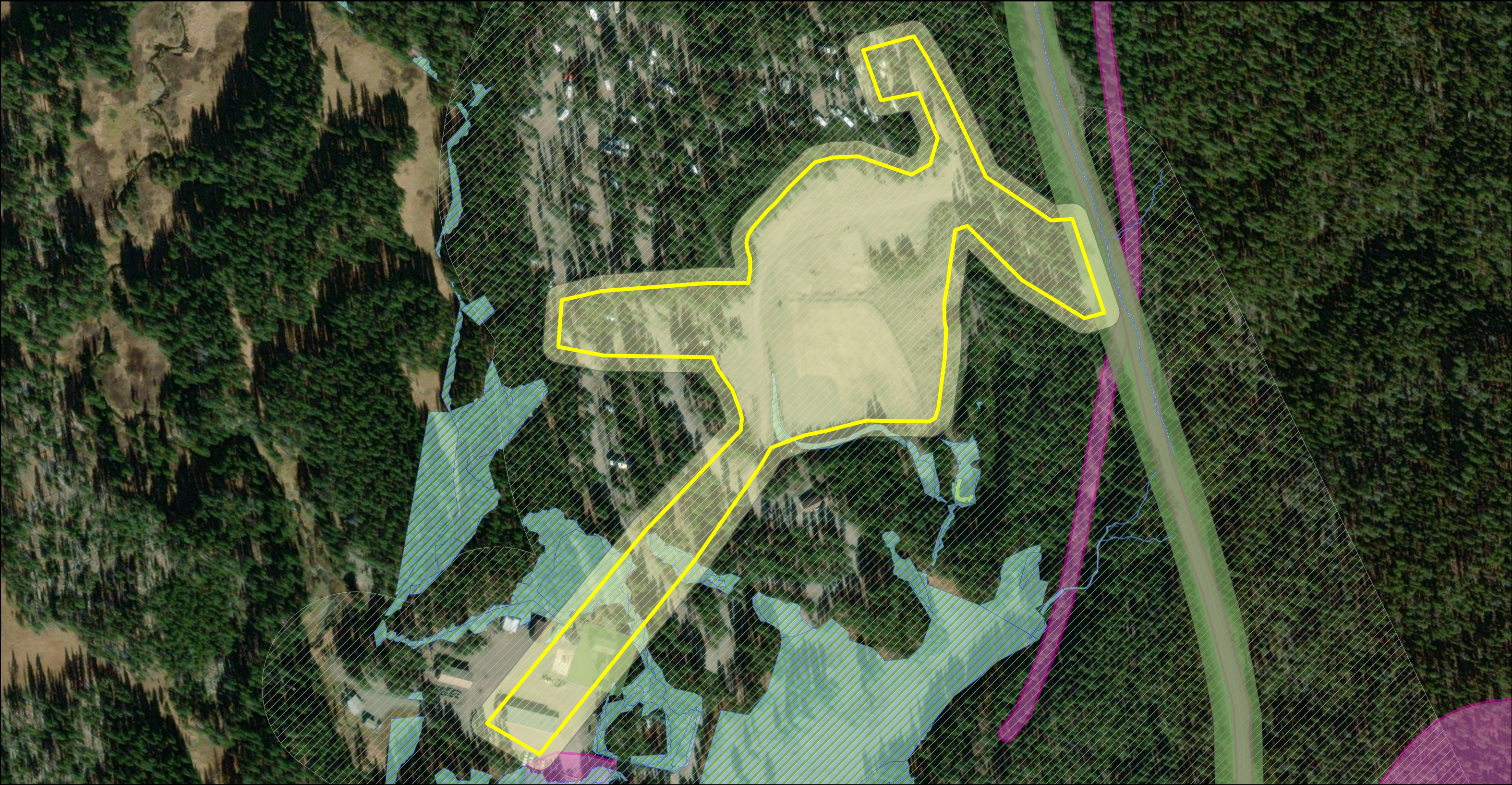
- Assessment of Effect - NAGPRA : In the event that human remains or other items that fall under the purview of NAGPRA are discovered during construction activities, all work on the project must stop and the park archeologist contacted immediately. As required by law, the coroner will be notified first. All provisions outlined in the Native American Graves Protection and Repatriation Act (1990) will be followed.
- Assessment of Effect : Project will ensure vegetation continues to screen views of development (such as the NPS government areas) from the Grand Loop Road Historic District (48YE520) by retaining trees of varied maturation that provide both understory and canopy trees.
- Wildlife : To avoid impacts to migratory birds during nesting season, please consider conducting all vegetation removal activities outside of March 1 - August 15th for raptors, and May 1 - August 15th for songbirds. If you are within the March 1 - August 15 window, and you suspect active nests from detection of physical structures (e.g. large collections of sticks or smaller plant material in nest-like shape, cavity holes) or behaviors (e.g. birds in and out of tree cavities, activity at nest-like structures in trees, birds carrying food into nest-like structures), please contact the Bird Program Manager at 307-344-2218 or david_b_haines@nps.gov to discuss or schedule a survey.
- Soils, Topography, Geology - Disturbance : To minimize the amount of ground disturbance, staging and stockpiling areas shall be located in previously disturbed sites, away from visitor use areas to the greatest extent possible. All staging and stockpiling areas shall be returned to pre-construction conditions following construction.
- Park Operations & Mgmt - Construction General : To the extent practical, work shall be scheduled to avoid construction activity and construction related delays during peak visitation times. No holiday or night time work shall be allowed. Weekend work (Friday through Sunday) shall not be allowed unless authorized in writing by the park's Superintendent.
- Park Operations & Mgmt - Communications : Project manager will ensure residents are properly notified of project related activities including closures, detours, power outages, and invasive plant treatment as necessary, prior to commencement of the aforementioned activities.
- Park Operations & Mgmt - Communications : Contractors would coordinate with park staff to reduce disruption in normal park activities (i.e. facilitate emergency traffic, and hauling material, to allow for visitor use in areas where no conflicts or safety concerns exist).
- Other : To minimize the amount of ground disturbance, staging and stockpiling areas would be located in previously disturbed sites if at all possible. All staging and stockpiling areas would be returned to pre-construction conditions following construction. Construction zones and staging areas would be identified and fenced with construction tape, snow fencing, or some similar material prior to any construction activity. The fencing would define the construction zone and confine activity to the minimum area required for construction.
- Other : Please contact your compliance representative if the scope of work changes to ensure proper compliance documentation has been completed. Upon project completion, please send a written summary, with photos if possible, to close out the administrative record for your project.
- Night Sky : Project shall comply with NPS and park lighting guidelines to reduce impacts to the night sky and wildlife. This will include, but is not limited to, low-level lighting, minimized glare, downward focused light fixtures, and energy efficient light sources such as low-pressure sodium lamps.
- Human Health & Safety : Line locates must be completed before any excavation work may begin. The depth of utility line varies and there may be multiple utility lines in a common area. Digging without calling can disrupt service, harm you and those around you and potentially result in fines and repair costs. Calling 811 before every job gets underground utility lines marked for free and helps prevent undesired consequences.
- Assessment of Effect - Museum Collections & Archives : Any and all historic objects discovered during this project (i.e. under foundations, in wall, attic, or crawl spaces, etc.) remain property of the federal government and shall be considered by the YELL Collections Committee for accessioning into the park unit's museum collection whether they are stored at an NPS facility or placed on loan to an agreed upon repository.
- Rare, Threatened & Endangered Species : The project lead will ensure that all project-related employees, such as contract employees, would be given orientation on how to avoid disturbing or encountering bears and how to minimize unavoidable effects or encounters. Orientation would include information about park regulations regarding food storage, disposal of garbage and other bear attractants, and approaching or harassing wildlife.
- Rare, Threatened & Endangered Species : Ensure work crews adhere to bear safety and food storage regulations.

Recommendations for Conditions or Stipulations:

None

Canyon Boneyard

Potential Housing Sites



North



0 25 50 100 Meters

0 50 100 200 300 Feet

 Approximate Construction Area

 Approx Construction Area - 33 foot buffer

 Rare Plants

 Wetlands

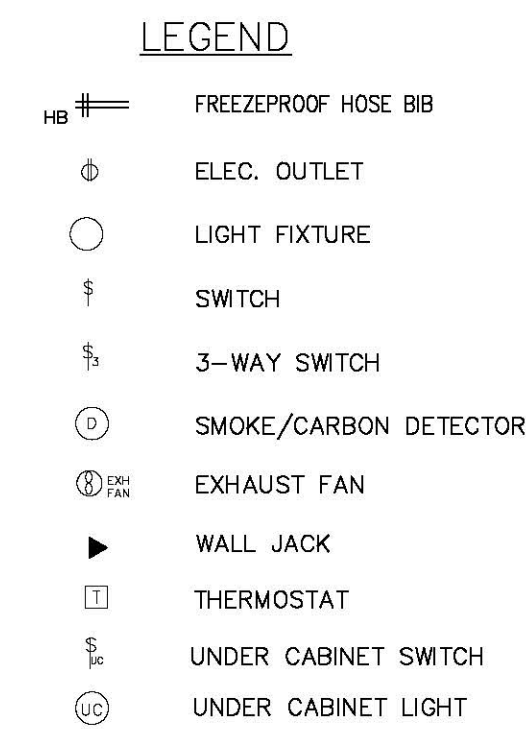
 Archeology Sites

 Grizzly Bear Conservation Strategy Boundary

 National Register of Historic Places

 Historic District

Yellowstone Center for Resources
Spatial Analysis Center
6/26/2024



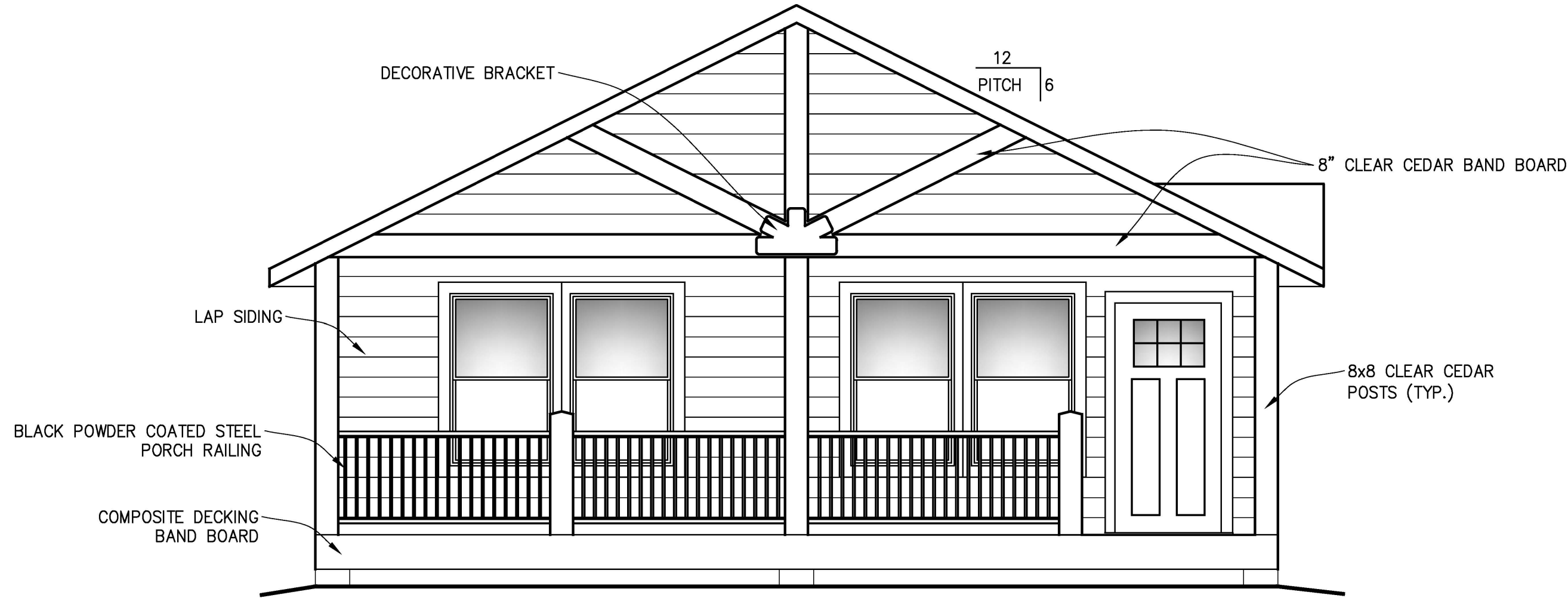
1. ALL DIMENSIONS ON THIS PLAN ARE TO THE FACE OF STUD OR POST UNLESS NOTED OTHERWISE.
2. ALL EXTERIOR WALLS ARE 2x6 AT 16"o/c AT RESIDENCE AND 2x6 AT 16"o/c AT GARAGE. ALL INTERIOR WALLS ARE 2x4 AT 16"o/c UNLESS NOTED OTHERWISE.
3. SEE SHEET #2 FOR ADDITIONAL NOTES AND ROOM FINISH, DOOR AND WINDOW SCHEDULES.

<u>FOOTAGE</u>	
LIVABLE SPACE	1060 SF
PORCH	224 SF

SHEET NUMBER

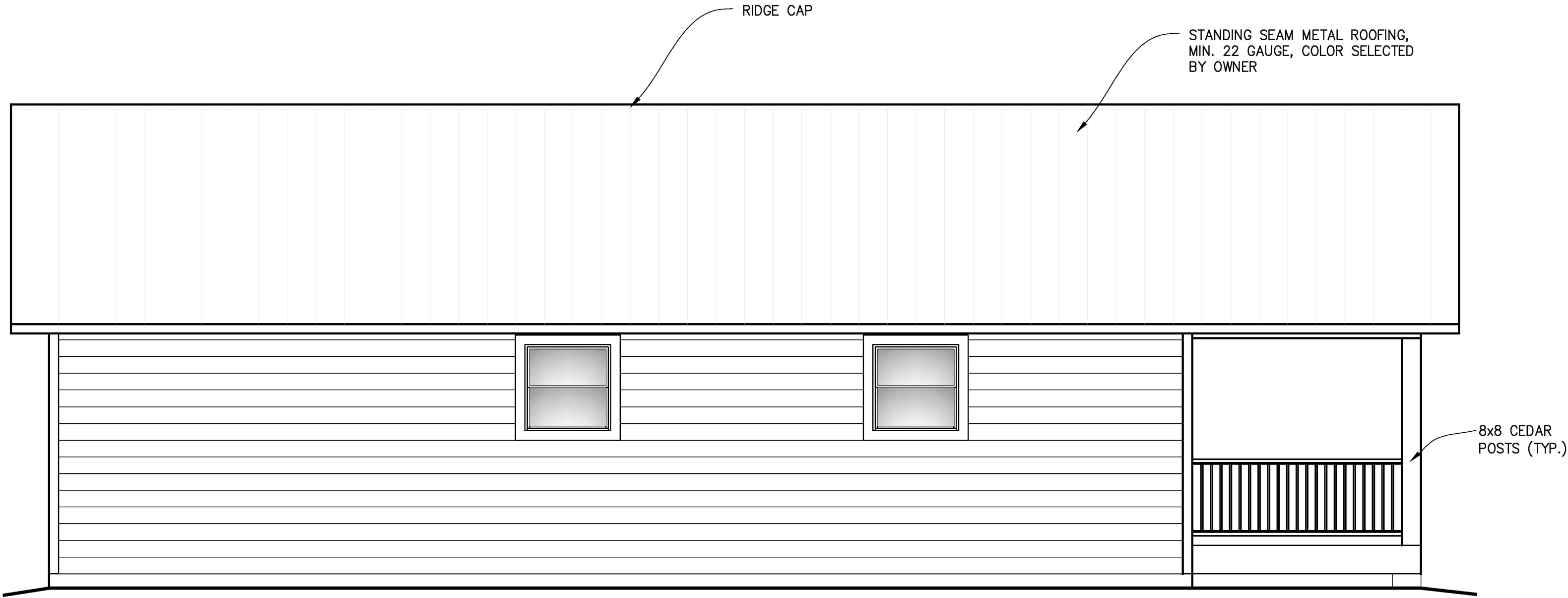
3

7 SHEETS



FRONT ELEVATION

SCALE: 1/4" = 1'-0"



LEFT SIDE ELEVATION

SCALE: 3/16" = 1'-0"

VERIFY SCALE!
IF THESE PRINTS ARE
REDUCED, FOLLOW
DIMENSIONS ONE INCH ON
ORIGINAL DRAWING.
MODIFY SCALE
ACCORDINGLY!

REVISIONS				NO.	DESCRIPTION	DATE	BY

YELLOWSTONE NATIONAL PARK
22 STABLE STREET
YNP, WY 82190

DRAWN BY: KS
CHK'D BY:
APPR. BY:
DATE: 1/2024

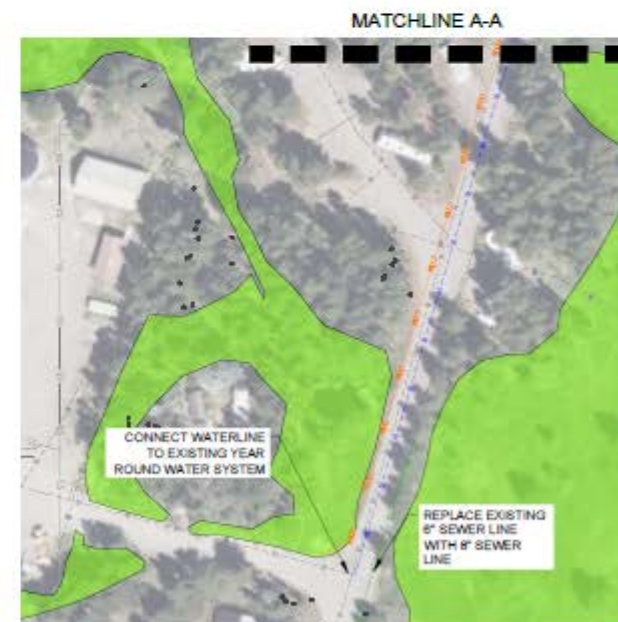
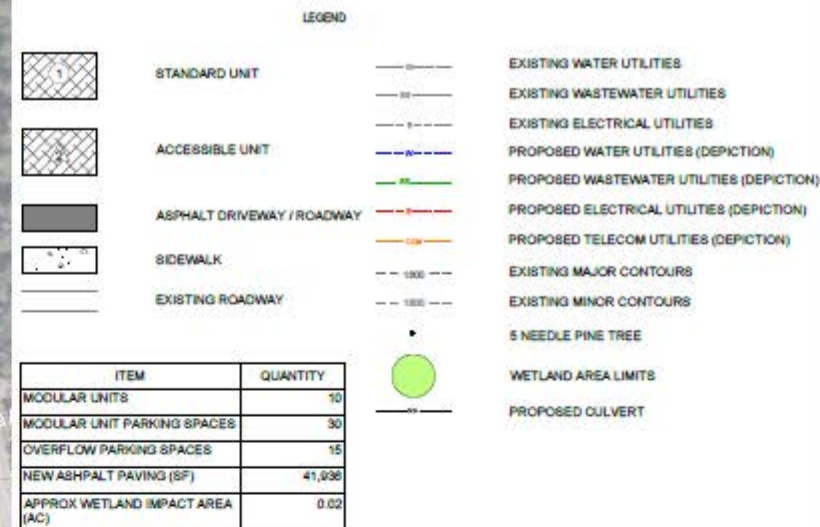
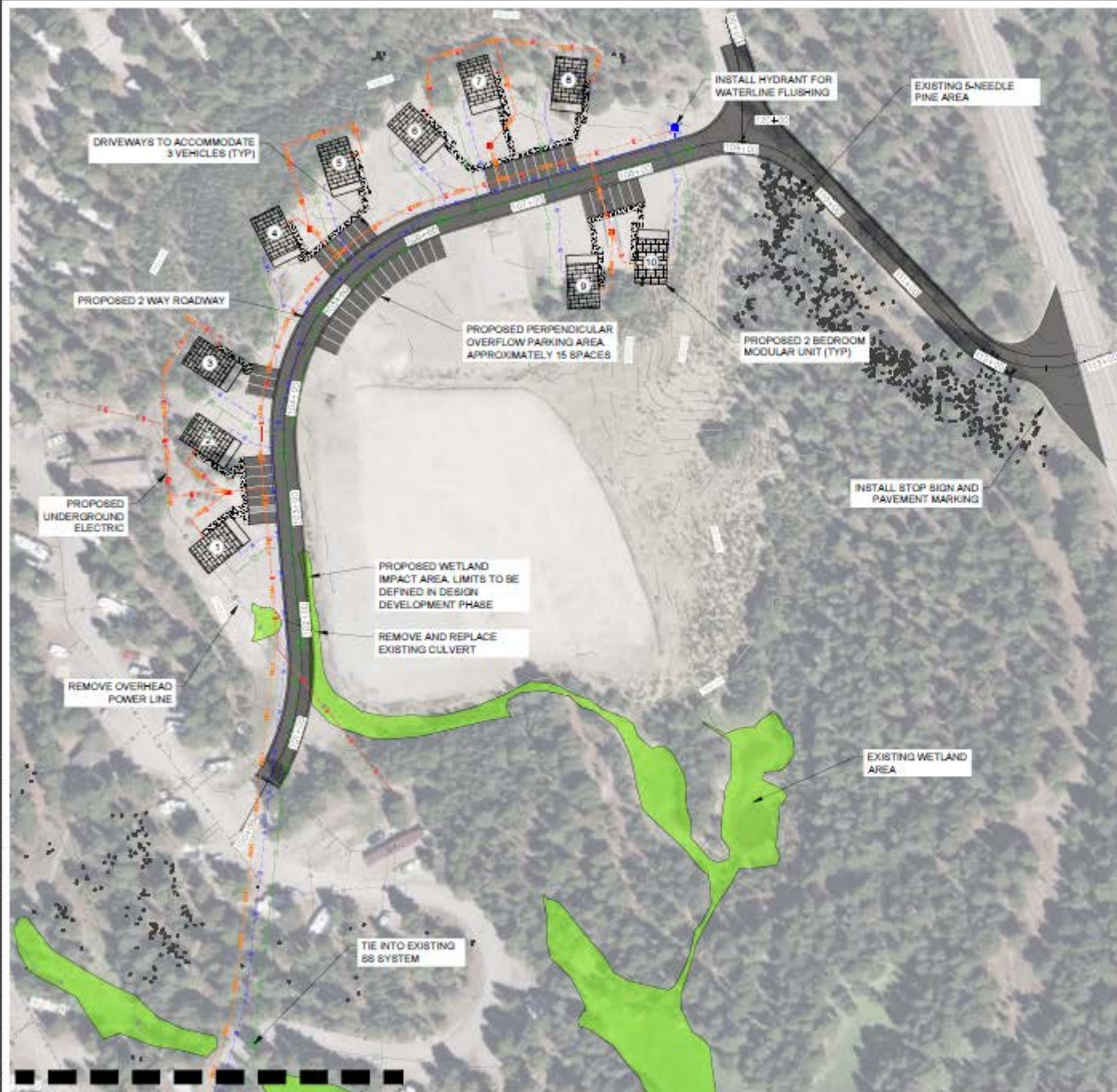
EMPLOYEE HOUSING
TWO BEDROOM AND
2 BATHROOM MODULAR

SHEET NUMBER

4

OF 7 SHEETS





WATERLINE CONNECTION

**MATCHLINE A-A -
SEE WATERLINE CONNECTION INSET MAP**



DESIGNED: T.H. WHITE CHECKED: C.B. WHITE DATE: 12/10/24	SUB SHEET NO. C3.1	TITLE OF SHEET CANYON VILLAGE PREFERRED ALTERNATIVE CANYON VILLAGE MODULAR UNITS YELLOWSTONE NATIONAL PARK	DRAWING NO. YELL 101/192110 PANEL/FIG NO. 32614/4/326100 SHEET 1 OF 3

Project Title: Lower Mammoth Goal IV Housing
Milestones# 2023-157

PEPC Project Number: 120149

Recommended by the following compliance specialists:

NEPA - Compliance Branch Chief Digital Signature: CHRISTINE GABRIEL Digitally signed by CHRISTINE GABRIEL
Date: 2025.02.27 11:41:48 -07'00'

NHPA - Cultural Resources Branch Chief Digital Signature: TOBIN ROOP Digitally signed by TOBIN ROOP
Date: 2025.02.27 16:18:26 -07'00'

Compliance Package Prepared By: Bonnie McDonald

Superintendent Review and Approval

The Environmental Screening Form has been reviewed.

AND

The Assessment of Actions Having an Effect on Historic Properties has been reviewed. The proposed work conforms to the *NPS Management Policies* and *Cultural Resource Management Guideline*, and I have reviewed and approve the recommendations, stipulations, or conditions noted in Section C of this form.

AND

The Categorical Exclusion has been reviewed. Decision: I find that the action fits within the categorical exclusion below. Therefore, I am categorically excluding the described project from further NEPA analysis. No extraordinary circumstances apply.

Superintendent Approval Digital Signature: CAMERON SHOLLY Digitally signed by CAMERON SHOLLY
Date: 2025.02.28 11:09:49 -07'00'



Categorical Exclusion Documentation Form (CE Form)

Project: Lower Mammoth - Goal IV Housing

PEPC Project Number: 120149

Description of Action (Project Description):

Yellowstone National Park (YNP) is located in a remote area, mostly surrounded by publicly-owned land. Park headquarters are located in Mammoth Hot Springs, which is five miles from the nearest gateway community, Gardiner, Montana. Housing costs in Gardiner and the surrounding area have risen sharply in recent years, with the average home price in Gardiner being in the \$850,000 range. Consequently, few of the park's employees can afford to live outside the park. Housing inside the park is scarce and often in poor condition, although we are in the midst of a multi-year effort to improve existing housing. However, the park does not contain enough housing to accommodate the approximately 800 year-round employees necessary for park operations. The housing shortage has negatively impacted our ability to attract qualified employees to fill permanent positions. As a result, YNP is proposing to increase employee housing units in a variety of locations and configurations in the coming years, including in the Lower Mammoth area.

The proposed housing would be four three-bedrooms and two-bathroom modular housing units with garages. Three of the units would be grouped together on Powerhouse Road. The fourth unit would be added to top of Lower Mammoth Service Road. The houses would be 28-feet by 56-feet. The exterior finishes will be similar to modulares installed across the park in recent years: traditional design with timber accents and neutral browns in color. Exterior lights would be "down" lighting as to help protect night skies. Work would include sewer, water, power telecoms, and associated street improvements. Staging would occur in the Mammoth boneyard.

All four of the proposed houses would be in the Lower Mammoth area which is part of which is contributing to the Mammoth Hot Springs Historic District (48YE486). Three of the units would also be in view of the North Entrance Road Historic District (48YE822). YNP Cultural Resources staff determined that the proposed housing units would not constitute an adverse effect to the historic properties within the area of potential effects. Wyoming SHPO concurred with these findings on February 5, 2025. See Internal Documents for correspondence.

YNP biologists determined that the proposed work would have no effect to species protected by the endangered species act. There is no presence of whitebark pine, it is not lynx critical habitat, and there are no records of lynx or wolverine. The project area is within the development footprint of Mammoth managed for humans, not grizzly bears.

The proposed work would be performed by independent contractors and would begin in spring 2025.

Additional compliance action would be needed if utilities need to be moved outside of the proposed area of impact.

Project Locations:

Location

County: Park **State:** MT

Mitigation(s):

- Park staff must be notified of implementation prior to commencement of project activities. Local residents, Little People's Learning Center, Snoopy School, persons associated with the Mammoth Community Cener, and relevant

NPS staff should be notified of construction timelines, road closures, power or water disruptions, and material and equipment staging locations.

- To avoid impacts to migratory birds during nesting season, please consider conducting all vegetation removal activities outside of March 1 - August 15th for raptors, and May 1 - August 15th for songbirds. If you are within the March 1 - August 15 window, and you suspect active nests from detection of physical structures (e.g. large collections of sticks or smaller plant material in nest-like shape, cavity holes) or behaviors (e.g. birds in and out of tree cavities, activity at nest-like structures in trees, birds carrying food into nest-like structures), please contact the Bird Program Manager david_b_haines@nps.gov to discuss or schedule a survey.
- Line locates must be completed before any excavation work may begin. The depth of utility line varies and there may be multiple utility lines in a common area. Digging without calling can disrupt service, harm you and those around you and potentially result in fines and repair costs. Calling 811 before every job gets underground utility lines marked for free and helps prevent undesired consequences.
- Project shall comply with NPS and park lighting guidelines to reduce impacts to the night sky and wildlife. This will include, but is not limited to, low-level lighting, minimized glare, downward focused light fixtures, and energy efficient light sources such as low-pressure sodium lamps.
- Please contact your compliance representative if the scope of work changes to ensure proper compliance documentation has been completed. Upon project completion, please send a written summary, with photos if possible, to close out the administrative record for your project.
- All material brought into the park from outside sources must be certified weed-free fill obtained from a recently certified facility. Please contact to Yellowstone Center for Resources for the most up to date list of certified facilities in the GYE.
- To minimize the amount of ground disturbance, staging and stockpiling areas would be located in previously disturbed sites if at all possible. All staging and stockpiling areas would be returned to pre-construction conditions following construction. Construction zones and staging areas would be identified and fenced with construction tape, snow fencing, or some similar material prior to any construction activity. The fencing would define the construction zone and confine activity to the minimum area required for construction.
- Contractors would coordinate with park staff to reduce disruption in normal park activities (i.e. facilitate emergency traffic, and hauling material, to allow for visitor use in areas where no conflicts or safety concerns exist).
- To the extent practical, work shall be scheduled to avoid construction activity and construction related delays during peak visitation times. No holiday or night time work shall be allowed. Weekend work (Friday through Sunday) shall not be allowed unless authorized in writing by the park's Superintendent.
- The project lead will ensure that all project-related employees, such as contract employees, would be given orientation on how to avoid disturbing or encountering bears and how to minimize unavoidable effects or encounters. Orientation would include information about park regulations regarding food storage, disposal of garbage and other bear attractants, and approaching or harassing wildlife.
- Ensure work crews adhere to bear safety and food storage regulations.
- To minimize the amount of ground disturbance, staging and stockpiling areas shall be located in previously disturbed sites, away from visitor use areas to the greatest extent possible. All staging and stockpiling areas shall be returned to pre-construction conditions following construction.
- All erosion and sediment control devices shall be adequately maintained to assure continued performance of their intended function. Those that have sustained damage or have reached their capability shall be replaced or maintenance performed.
- All equipment and tools shall be cleaned completely prior to entering the work zone to prevent the spreading of non-invasive plant seeds. Equipment shall be inspected for compliance.
- In the event that human remains are discovered during fuels reduction activities, all activities in the vicinity of the discovery must stop and the Park Archeologist, Branch Chief of Cultural Resources, NPS Supervisory LE Ranger for Mammoth contacted immediately. If the remains are determined to have no forensic value and are of Native American or Native Hawaiian descent or an historical person, all provisions outlined in the Native American Graves Protection and Repatriation Act (1990), as amended, will be followed.
- If previously unknown archeological or paleontological resources are discovered during construction activities, all ground disturbing activities in the immediate vicinity (300 feet) of the discovery shall be halted and the Park Archaeologist notified immediately. Cultural resources will be identified and documented by an archaeologist meeting the NPS Qualification Standards and the Secretary of the Interior's Professional Qualification Standards. An appropriate mitigation strategy will be developed, if necessary, in accordance with pertinent laws and regulations.

CE Citation: 3.3.C.18 Construction of minor structures, including small improved parking lots, in previously disturbed or developed areas.

CE Justification:

This project proposes to infill modular housing within the previously disturbed area of the established Lower Mammoth housing area. There would be no significant impact to natural or cultural resources by the project as proposed, providing mitigation measures are followed. Therefore, Categorical Exclusion 3.3.C.18 applies.

Decision: I find that the action fits within the categorical exclusion above. Therefore, I am categorically excluding the described project from further NEPA analysis. No extraordinary circumstances apply.

Executive Order 14154, Unleashing American Energy (Jan. 20, 2025), and a Presidential Memorandum, Ending Illegal Discrimination and Restoring Merit-Based Opportunity (Jan. 21, 2025), require the Department to strictly adhere to the National Environmental Policy Act (NEPA), 42 U.S.C. §§ 4321 et seq. Further, such Order and Memorandum repeal Executive Orders 12898 (Feb. 11, 1994) and 14096 (Apr. 21, 2023). Because Executive Orders 12898 and 14096 have been repealed, complying with such Orders is a legal impossibility. The NPS verifies that it has complied with the requirements of NEPA, including the Department's regulations and procedures implementing NEPA at 43 C.F.R. Part 46 and Part 516 of the Departmental Manual, consistent with the President's January 2025 Order and Memorandum

Extraordinary Circumstances:

If implemented, would the proposal...	Yes/No	Explanation
A. Have significant impacts on public health or safety?	No	The project proposal to build four housing units in Lower Mammoth would have positive impacts to employee health and safety. These units would provide safe and secure housing for several National Park Service families. These families would be able to join an established housing area with mental health services, fitness center, daycare services, and a preschool which would provide a sense of security and community.
B. Have significant impacts on such natural resources and unique geographic characteristics as historic or cultural resources; park, recreation, or refuge lands; wilderness areas; wild or scenic rivers; national natural landmarks; sole or principal drinking water aquifers; prime farmlands; wetlands (Executive Order 11990); floodplains (Executive Order 11988); national monuments; migratory birds; and other ecologically significant or critical areas?	No	This proposed project occurs within a previously disturbed area within the Lower Mammoth housing area. It would not have significant impacts on natural or cultural resources. It would occur outside the recommended wilderness boundary. It does not have impacts to wild or scenic rivers, landmarks, wetlands, floodplains, national monuments, migratory birds or ecologically critical or significant areas.
C. Have highly controversial environmental effects or involve unresolved conflicts concerning alternative uses of available resources (NEPA section 102(2)(E))?	No	The use of previously disturbed area to infill NPS employee housing within an established housing area is not considered controversial.
D. Have highly uncertain and potentially significant environmental effects or involve unique or unknown environmental risks?	No	This circumstance does not apply because the project is occurring within the footprint of previous disturbance. The proposed project does not have highly uncertain or potentially significant environmental impacts or risks.
E. Establish a precedent for future action or represent a decision in principle about future actions with potentially significant environmental effects?	No	This project does not establish a precedent for future action because potential future projects with similar scope are unlikely to have the potential for significant environmental effects. The infill of housing within established housing areas would be a sustainable mechanism to address shifting park needs while limiting the expansion of developed areas and the overall building footprint parkwide.
F. Have a direct relationship to other actions with individually insignificant, but cumulatively significant, environmental effects?	No	This extraordinary circumstance does not apply because the project is within the previous disturbance Lower Mammoth housing development. This project would occur within the previous footprint of a motor camp, so no new area would be disturbed and thus no new cumulatively significant environmental effects.
G. Have significant impacts on properties listed or eligible for listing on the National Register of Historic Places, as determined by either the bureau or office?	No	All four of the proposed houses would be in the Lower Mammoth area which is part of which is contributing to the Mammoth Hot Springs Historic District (48YE486). Three of the units would also be in view of the North Entrance Road Historic District (48YE822). YNP Cultural Resources staff determined that the proposed housing units would not constitute an adverse effect to the historic properties within the area of potential effects. The Wyoming SHPO concurred with these findings.
H. Have significant impacts on species listed or proposed to be listed on the List of Endangered or Threatened Species,	No	The proposed project would have no significant impacts on species protected by the Endangered Species Act. No presence of whitebark pine, not lynx critical habitat, and

or have significant impacts on designated Critical Habitat for these species?		no records of lynx or wolverine. Project is within development footprint of Mammoth managed for humans, not grizzly bears.
I. Violate a federal, state, local or tribal law or requirement imposed for the protection of the environment?	No	This project does not violate federal, state, local, or tribal law or requirement imposed for the protection of the environment.
J. Have a disproportionately high and adverse effect on low income or minority populations (EO 12898)?	No	This circumstance is not applicable because housing in the park is only available to employees working in the park and their families. The President has revoked Executive Order 12898.
K. Limit access to and ceremonial use of Indian sacred sites on federal lands by Indian religious practitioners or adversely affect the physical integrity of such sacred sites (EO 130007)?	No	This is not applicable because access to and ceremonial use of indigenous sacred sites would not be limited.
L. Contribute to the introduction, continued existence, or spread of noxious weeds or non-native invasive species known to occur in the area or actions that may promote the introduction, growth, or expansion of the range of such species (Federal Noxious Weed Control Act and Executive Order 13112)?	No	This project would not contribute to the introduction or spread of noxious weeds or nonnative invasive species because mitigations are in place to limit the spread of such vegetation.



ENVIRONMENTAL SCREENING FORM (ESF)

Updated Sept 2015 per NPS NEPA Handbook

A. PROJECT INFORMATION

Project Title: Lower Mammoth - Goal IV Housing
PEPC Project Number: 120149
PMIS Number:
Project Type: Other Maintenance Activities (MNT)
Project Location:
County, State: Park, Montana
Project Leader: Robert Kammel

B. PROJECT DESCRIPTION

Yellowstone National Park (YNP) is located in a remote area, mostly surrounded by publicly-owned land. Park headquarters are located in Mammoth Hot Springs, which is five miles from the nearest gateway community, Gardiner, Montana. Housing costs in Gardiner and the surrounding area have risen sharply in recent years, with the average home price in Gardiner being in the \$850,000 range. Consequently, few of the park's employees can afford to live outside the park. Housing inside the park is scarce and often in poor condition, although we are in the midst of a multi-year effort to improve existing housing. However, the park does not contain enough housing to accommodate the approximately 800 year-round employees necessary for park operations. The housing shortage has negatively impacted our ability to attract qualified employees to fill permanent positions. As a result, YNP is proposing to increase employee housing units in a variety of locations and configurations in the coming years, including in the Lower Mammoth area.

The proposed housing would be four three-bedrooms and two-bathroom modular housing units with garages. Three of the units would be grouped together on Powerhouse Road. The fourth unit would be added to top of Lower Mammoth Service Road. The houses would be 28-feet by 56-feet. The exterior finishes will be similar to modulars installed across the park in recent years: traditional design with timber accents and neutral browns in color. Exterior lights would be "down" lighting as to help protect night skies. Work would include sewer, water, power telecoms, and associated street improvements. Staging would occur in the Mammoth boneyard.

All four of the proposed houses would be in the Lower Mammoth area which is part of which is contributing to the Mammoth Hot Springs Historic District (48YE486). Three of the units would also be in view of the North Entrance Road Historic District (48YE822). YNP Cultural Resources staff determined that the proposed housing units would not constitute an adverse effect to the historic properties within the area of potential effects. Wyoming SHPO concurred with these findings on February 5, 2025. See Internal Documents for correspondence.

YNP biologists determined that the proposed work would have no effect to species protected by the endangered species act. There is no presence of whitebark pine, it is not lynx critical habitat, and there are no records of lynx or wolverine. The project area is within the development footprint of Mammoth managed for humans, not grizzly bears.

The proposed work would be performed by independent contractors and would begin in spring 2025.

Additional compliance action would be needed if utilities need to be moved outside of the proposed area of impact.

C. RESOURCE IMPACTS TO CONSIDER:

Resource	Potential for Impact	Potential Issues & Impacts
Air Air Quality <i>Air Quality</i>	Potential	Issue: Exhaust and dust generated from construction activities and equipment Impact: Air quality would be temporarily degraded due to construction dust during the construction period. Local emissions from construction equipment would occur during this same time.
Biological Nonnative or Exotic Species <i>Nonnative or Exotic Species</i>	Potential	Issue: Spread or introduction of nonnative vegetation. Impact: Nonnative plants may be spread or introduced during ground-disturbing activities or by equipment travel from one area to another. Mitigation measures and a vegetation management plan will be needed prior to implementation.
Biological Species of Special Concern or Their Habitat <i>Species of Special Concern or Their Habitat</i>	None	Impact: The proposed project would have no significant impacts on species protected by the Endangered Species Act. No presence of whitebark pine, not lynx critical habitat, and no records of lynx or wolverine. Project is within development footprint of Mammoth managed for humans, not grizzly bears.
Biological Vegetation <i>Mature sage brush</i>	Potential	Issue: Mature sage brush removal would be required to install utilities and the modular homes.
Biological Wildlife and/or Wildlife Habitat including terrestrial and aquatic species <i>Wildlife habitat</i>	Potential	Issue: Mature sage brush removal will be required to install utilities and the modular homes. Impact: Removal of some sagebrush would negatively impact the micro-ecosystem dependent on those shrubs (insects, small mammals) until they were able to move to a nearby area.
Cultural Archeological Resources <i>Subsurface archaeological resources</i>	Potential	Issue: Archeological resources are well documented within development areas. Although unlikely, ground disturbance during construction may uncover previously unknown archaeological resources. Mitigation measures would be in place to address inadvertent discovery and minimize any potential resource impacts in areas that do not have surface archaeological resources.
Cultural Cultural Landscapes <i>Historic District</i>	Potential	Issue: Proposed new housing sites 1 and 3 is within Mammoth Hot Springs Historic District (48YE486) and housing sites 2 and 3 are within the viewshed of Fort Yellowstone NHL. Impact: All four of the proposed houses would be in the Lower Mammoth area which is part of which is contributing to the Mammoth Hot Springs Historic District (48YE486). Three of the units would also be in view of the North Entrance Road Historic District (48YE822). YNP Cultural Resources staff determined that the proposed housing units would not constitute an adverse effect to the historic properties within the area of potential effects. The Wyoming SHPO concurred with these findings.

Cultural Ethnographic Resources <i>Ethnographic Resources</i>	Potential	Issue: Tribes have identified some plants and animals in the park that are ethnographically significant. Ground disturbance associated with this project could expose previously unknown ethnographic resources. Impact: Ground disturbance work could damage or destroy previously unknown resources. However, mitigations are in place if such resources are found during work. Additionally, if the project would disturb these resources the tribes will be consulted.
Cultural Museum Collections <i>Objects and Specimens</i>	Potential	Issue: Ground disturbance associated with this project could expose previously unknown objects or specimens of interest by Yellowstone National Park museum staff. Impact: Ground disturbance work could damage or destroy previously unknown resources. However, mitigations are in place if such resources are found during work.
Cultural Prehistoric/historic structures <i>historic structures</i>	Potential	Impact: All four of the proposed houses would be in the Lower Mammoth area which is part of which is contributing to the Mammoth Hot Springs Historic District (48YE486). Three of the units would also be in view of the North Entrance Road Historic District (48YE822). YNP Cultural Resources staff determined that the proposed housing units would not constitute an adverse effect to the historic properties within the area of potential effects. The Wyoming SHPO concurred with these findings.
Geological Geologic Features <i>Soils</i>	Potential	Issue: Ground disturbance is necessary for this project. Impact: Minor, short-and long-term impacts will occur to the geological resources in the project area due to excavation necessary to perform this project. Mitigations are in place in the event that cultural resources are found during excavation.
Geological Geologic Processes <i>Geologic Processes</i>	None	Impact: No known geologic processes would be impacted by this project.
Lightscapes Lightscapes <i>Night Skies</i>	Potential	Impact: Increasing housing capacity in the park will inherently increase the number of light sources available to contribute to the degradation of night skies. However, it is not expected that the implementation of this project would degrade the quality of night sky in the park to a point where it would be noticeably apparent.
Other Human Health and Safety <i>Human Health and Safety</i>	None	Impact: Building new, secure, and cleaning housing would positively impact NPS employees.
Paleontological Paleontological Resources <i>Paleontological Resources</i>	None	Impact: No known paleontological resources would be impacted by this project.
Socioeconomic Land Use		

Socioeconomic Socioeconomic		
Soundscapes Soundscapes <i>Soundscapes</i>	Potential	Impact: Noise from construction activities may temporarily disrupt the experience of visitors at the Mammoth Campground, the residents of the Lower Mammoth housing area, and wildlife within the immediate vicinity. However, this is a temporary disruption and would occur during daytime hours.
Viewsheds Viewsheds <i>Viewsheds</i>	Potential	Issue: Disruption of natural landscape Impact: The proposed housing site is within view of the public. The installation of additional housing will disrupt the current natural landscape. The proposed sites were selected with resources in mind. The addition of these housing units will blend well with the current established housing.
Visitor Use and Experience Recreation Resources <i>Recreation Resources, NPS Staff</i>	Potential	Impact: The availability of safe, secure, and comfortable NPS-staff housing will help Yellowstone National Park maintain its workforce which would help keep the Park at a higher level of service for visitors.
Visitor Use and Experience Visitor Use and Experience <i>Visitor Use and Experience</i>	None	Impact: The proposed project would not impact visitor use or experience as construction would be during daylight areas and is within a NPS housing area.
Water Floodplains <i>Floodplains</i>	None	Impact: There are no floodplains within the construction boundary of the proposed project.
Water Water Quality or Quantity <i>Water Quality</i>	Potential	Issue: Temporary water (rain, snow-melt runoff) turbidity during ground disturbance. Impact: Negligible short-and long-term adverse impacts to water quality may occur during ground disturbance activities. Mitigations are in place to reduce/prevent the runoff of turbid water during rain events.
Water Wetlands <i>Wetlands</i>	None	Impact: There are no wetlands in the area of impact.
Wilderness Wilderness <i>Wilderness</i>	None	Impact: The proposed work would be out of the recommended wilderness boundary.

D. ESF ADDENDUM QUESTIONS:

Question	Answer	Notes



ASSESSMENT OF ACTIONS HAVING AN EFFECT ON HISTORIC PROPERTIES

A. DESCRIPTION OF UNDERTAKING

1. **Park:** Yellowstone National Park

2. **Project Description:**

Project Name: Lower Mammoth - Goal IV Housing

Prepared by: Elizabeth Horton **Date Prepared:** 11/30/2023 **Telephone:** (307) 344-2290

PEPC Project Number: 120149

Locations:

County, State: Park, MT

Describe project:

Yellowstone National Park (YNP) is located in a remote area, mostly surrounded by publicly-owned land. Park headquarters are located in Mammoth Hot Springs, which is five miles from the nearest gateway community, Gardiner, Montana. Housing costs in Gardiner and the surrounding area have risen sharply in recent years, with the average home price in Gardiner being in the \$850,000 range. Consequently, few of the park's employees can afford to live outside the park. Housing inside the park is scarce and often in poor condition, although we are in the midst of a multi-year effort to improve existing housing. However, the park does not contain enough housing to accommodate the approximately 800 year-round employees necessary for park operations. The housing shortage has negatively impacted our ability to attract qualified employees to fill permanent positions. As a result, YNP is proposing to increase employee housing units in a variety of locations and configurations in the coming years, including in the Lower Mammoth area.

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The proposed work would be performed by independent contractors and would begin in spring 2025.

Additional compliance action would be needed if utilities need to be moved outside of the proposed area of impact.

Area of potential effects (as defined in 36 CFR 800.16[d])

Irregular shaped polygon. Direct effects are defined by ground disturbance related to building construction, associated utility

construction, and staging areas. Indirect effects are defined by the viewshed based on tree line, building placements, and slope topography.

3. Has the area of potential effects been surveyed to identify historic properties?

☐ No

☒ Yes

Source or reference:

4. Potentially Affected Resource(s):

Archeological Resources Present: No

Archeological Resources Notes: The park completed a cultural resources inventory for this area in 2009 (Sanders et al. [2009] 2009 Class III Cultural Resource Block Inventory of Portions of the Mammoth-Gardiner Developed Area, Yellowstone National Park, Wyoming and Montana). No archaeological resources were identified during pedestrian survey within the proposed housing area sites 1, 2 or 3 in Lower Mammoth.

Historical Structures/Resources Present: Yes

Historical Structures/Resources Notes: Mammoth Hot Springs Historic District (48YE486), the North Entrance Road (24YE031/48YE822), and Fort Yellowstone National Historic Landmark District (48YE1057)

Cultural Landscapes Present:

Ethnographic Resources Present:

Ethnographic Resources Notes: Tribes have identified all of YNP as containing ethnographic resources, however, none specific to the current project area have been identified. If ethnographic resource concerns are identified additional consultation will be needed.

5. The proposed action will: (check as many as apply)

☐ Destroy, remove, or alter features/elements from a historic structure

☐ Replace historic features/elements in kind

☐ Add non-historic features/elements to a historic structure

☒ Alter or remove features/elements of a historic setting or environment (inc. terrain)

☐ Add non-historic features/elements (inc. visual, audible, or atmospheric) to a historic setting or cultural landscape

☐ Disturb, destroy, or make archeological resources inaccessible

☐ Disturb, destroy, or make ethnographic resources inaccessible

☒ Potentially affect presently unidentified cultural resources

☐ Begin or contribute to deterioration of historic features, terrain, setting, landscape elements, or archeological or ethnographic resources

☐ Involve a real property transaction (exchange, sale, or lease of land or structures)

☐ Other (please specify): _____

6. Supporting Study Data:

(Attach if feasible; if action is in a plan, EA or EIS, give name and project or page number.)

B. REVIEWS BY CULTURAL RESOURCE SPECIALISTS

The park 106 coordinator requested review by the park's cultural resource specialist/advisors as indicated by check-off boxes or as follows:

No Reviews From: Curator, Archeologist, Historical Architect, Historian, 106 Advisor, Other Advisor, Anthropologist, Historical Landscape Architect

C. PARK SECTION 106 COORDINATOR'S REVIEW AND RECOMMENDATIONS

1. Assessment of Effect:

☐	No Potential to Cause Effects
☐	No Historic Properties Affected
☒	No Adverse Effect
☐	Adverse Effect

2. Documentation Method:

☒ Standard 36 CFR Part 800 Consultation

Further consultation under 36 CFR Part 800 is needed.

☐ Streamlined Review Under the 2008 Servicewide Programmatic Agreement (PA)

The above action meets all conditions for a streamlined review under section III of the 2008 Servicewide PA for Section 106 compliance.

☐ Program Comment on Stewardship and Management of National Park Service Mission 66-Era Facilities (1945-1972)

The above action meets all of the requirements of this Program Comment for Section 106 compliance and required documents have been uploaded.

☐ Undertaking Related to Park Specific or Another Agreement

The proposed undertaking is covered for Section 106 purposes under another document such as a park, region or statewide agreement established in accord with 36 CFR 800.7 or 36 CFR 800.14.

3. Consultation Information

SHPO Required: Yes

SHPO Sent: Jan 23, 2025

SHPO Received: Feb 5, 2025

THPO Required:

THPO Sent:

THPO Received:

SHPO/THPO Notes: No Adverse Effect

Advisory Council Participating: No

Advisory Council Notes:

Additional Consulting Parties: No

4. Stipulations and Conditions: Following are listed any stipulations or conditions necessary to ensure that the assessment of effect above is consistent with 36 CFR Part 800 criteria of effect or to avoid or reduce potential adverse effects.

If any previously unidentified cultural materials are discovered during construction, work in the area shall halt immediately, the federal agency and SHPO staff be contacted, and the materials be evaluated by an archaeologist or historian meeting the Secretary of the Interior's Professional Qualification Standards (48 FR 22716, Sept. 1983).

5. Mitigations/Treatment Measures: Measures to prevent or minimize loss or impairment of historic/prehistoric properties: (Remember that setting, location, and use may be relevant.)

Required Mitigations - For the proposed project actions to be within compliance requirements during construction and/or project implementation, the following mitigations must be adhered to:

- Park staff must be notified of implementation prior to commencement of project activities. Local residents, Little People's Learning Center, Snoopy School, persons associated with the Mammoth Community Center, and relevant NPS staff should be notified of construction timelines, road closures, power or water disruptions, and material and equipment staging locations.
- To avoid impacts to migratory birds during nesting season, please consider conducting all vegetation removal activities outside of March 1 - August 15th for raptors, and May 1 - August 15th for songbirds. If you are within the March 1 - August 15 window, and you suspect active nests from detection of physical structures (e.g. large collections of sticks or smaller plant material in nest-like shape, cavity holes) or behaviors (e.g. birds in and out of tree cavities, activity at nest-like structures in trees, birds carrying food into nest-like structures), please contact the Bird Program Manager david_b_haines@nps.gov to discuss or schedule a survey.
- Line locates must be completed before any excavation work may begin. The depth of utility line varies and there may be multiple utility lines in a common area. Digging without calling can disrupt service, harm you and those around you and potentially result in fines and repair costs. Calling 811 before every job gets underground utility lines marked for free and helps prevent undesired consequences.
- Project shall comply with NPS and park lighting guidelines to reduce impacts to the night sky and wildlife. This will include, but is not limited to, low-level lighting, minimized glare, downward focused light fixtures, and energy efficient light sources such as low-pressure sodium lamps.
- Please contact your compliance representative if the scope of work changes to ensure proper compliance documentation has been completed. Upon project completion, please send a written summary, with photos if possible, to close out the administrative record for your project.
- All material brought into the park from outside sources must be certified weed-free fill obtained from a recently certified facility. Please contact to Yellowstone Center for Resources for the most up to date list of certified facilities in the GYE.
- To minimize the amount of ground disturbance, staging and stockpiling areas would be located in previously disturbed sites if at all possible. All staging and stockpiling areas would be returned to pre-construction conditions following construction. Construction zones and staging areas would be identified and fenced with construction tape, snow fencing, or some similar material prior to any construction activity. The fencing would define the construction zone and confine activity to the minimum area required for construction.
- Contractors would coordinate with park staff to reduce disruption in normal park activities (i.e. facilitate emergency traffic, and hauling material, to allow for visitor use in areas where no conflicts or safety concerns exist).
- To the extent practical, work shall be scheduled to avoid construction activity and construction related delays during peak visitation times. No holiday or night time work shall be allowed. Weekend work (Friday through Sunday) shall not be allowed unless authorized in writing by the park's Superintendent.
- The project lead will ensure that all project-related employees, such as contract employees, would be given orientation on how to avoid disturbing or encountering bears and how to minimize unavoidable effects or encounters. Orientation would include information about park regulations regarding food storage, disposal of garbage and other bear attractants, and approaching or harassing wildlife.

- Ensure work crews adhere to bear safety and food storage regulations.
- To minimize the amount of ground disturbance, staging and stockpiling areas shall be located in previously disturbed sites, away from visitor use areas to the greatest extent possible. All staging and stockpiling areas shall be returned to pre-construction conditions following construction.
- All erosion and sediment control devices shall be adequately maintained to assure continued performance of their intended function. Those that have sustained damage or have reached their capability shall be replaced or maintenance performed.
- All equipment and tools shall be cleaned completely prior to entering the work zone to prevent the spreading of non-invasive plant seeds. Equipment shall be inspected for compliance.
- In the event that human remains are discovered during fuels reduction activities, all activities in the vicinity of the discovery must stop and the Park Archeologist, Branch Chief of Cultural Resources, NPS Supervisory LE Ranger for Mammoth contacted immediately. If the remains are determined to have no forensic value and are of Native American or Native Hawaiian descent or an historical person, all provisions outlined in the Native American Graves Protection and Repatriation Act (1990), as amended, will be followed.
- If previously unknown archeological or paleontological resources are discovered during construction activities, all ground disturbing activities in the immediate vicinity (300 feet) of the discovery shall be halted and the Park Archaeologist notified immediately. Cultural resources will be identified and documented by an archaeologist meeting the NPS Qualification Standards and the Secretary of the Interior's Professional Qualification Standards. An appropriate mitigation strategy will be developed, if necessary, in accordance with pertinent laws and regulations.

6. Assessment of Effect Notes:



Other Compliance/Consultations Form

Park Name: Yellowstone National Park

PEPC Project Number: 120149

Project Title: Lower Mammoth - Goal IV Housing

Project Type: Other Maintenance Activities : Replace Housing Lost to Flood

Project Location:

County, State: Park, MT

Project Leader: Robert Kammel

ESA

Any Federal Species in the project Area? Yes

If species in area: No Effect

Was Biological Assessment prepared? No

If Biological Assessment prepared, concurred?

Formal Consultation required? No

Formal Consultation Notes:

Formal Consultation Concluded:

Any State listed Species in the Project Area?

Consultation Information:

General Notes: No presence of WBP, not lynx critical habitat, and no records of lynx or wolverine. Project is within development footprint of Mammoth managed for humans, not grizzly bears.

Data Entered By: Daniel Stahler

Date: Feb 27, 2025

ESA Mitigations

Mitigation ID	Type	Text
175920	Rare, Threatened & Endangered Species	Ensure work crews adhere to bear safety and food storage regulations.
175921	Rare, Threatened & Endangered Species	The project lead will ensure that all project-related employees, such as contract employees, would be given orientation on how to avoid disturbing or encountering bears and how to minimize unavoidable effects or encounters. Orientation would include information about park regulations regarding food storage, disposal of garbage and other bear attractants, and approaching or harassing wildlife.

Floodplains/Wetlands/§404 Permits

Question	Yes	No	Details

A.1. Is project in 100- or 500-year floodplain or flash flood hazard area?		No	Not in floodplain or flash flood hazard area.
A.2. Is Project in wetlands as defined by NPS/DOI?		No	Not in wetland as defined by NPS/DOI.
B. COE Section 404 permit needed?		No	No placement of fill in waters of the United States.
C. State 401 certification?		No	
D. State Section 401 Permit?		No	Issue Date: Expiration Date:
E. Tribal Water Quality Permit?		No	
F. CZM Consistency determination needed?			N/A
G. Erosion & Sediment Control Plan Required?		No	
H. Any other permits required?		No	Permit Information:
Other Information:			

Data Entered By: Bonnie Mcdonald

Date: Feb 10, 2025

FloodPlains & Wetlands Mitigations

No FloodPlains & Wetlands mitigations are associated with this project.

Wilderness

Question	Yes	No	
A. Does this project occur in or adjacent to Designated, Recommended, Proposed, Study, Eligible, or Potential Wilderness?		No	
B. Is the only place to conduct this project in wilderness?		No	
C. Is the project necessary for the administration of the area as wilderness?		No	
D. Would the project or any of its alternatives adversely affect (directly or indirectly) Designated, Recommended, Proposed, Study, Eligible, or Potential Wilderness? (If Yes, Minimum Requirements Analysis required)		No	
E. Does the project or any of its alternatives involve the use of any of the Wilderness Act Section 4(c) prohibited uses: commercial enterprise, permanent road, temporary road, motor vehicles, motorized equipment, motorboats, landing of aircraft, mechanical transport, structure, or installation? (If Yes, Minimum Requirements Analysis required)		No	

If the answer to D or E above is "Yes" then a Minimum Requirements Analysis is required. Describe the status of this analysis in the column to the right.			Initiation Date: Completed Date: Approved Date: Date:
Other Information:			

Data Entered By: Bonnie Mcdonald
 Date: Jan 23, 2025

Other Permits/Laws *Questions A & B are no longer used.*

Question	Yes	No
C. Wild and scenic river concerns exist?		No
D. National Trails concerns exist?		No
E. Air Quality consult with State needed?		No
F. Consistent with Architectural Barriers, Rehabilitation, and Americans with Disabilities Acts or not Applicable? (If N/A check Yes)	Yes	
G. Other:		No

Other Information:

Data Entered By: Bonnie Mcdonald
 Date: Jan 23, 2025



Mitigations List Form

Date: February 27, 2025

Park: Yellowstone National Park

Project: Lower Mammoth - Goal IV Housing

PEPC Project Number: 120149

Project Description:

Yellowstone National Park (YNP) is located in a remote area, mostly surrounded by publicly-owned land. Park headquarters are located in Mammoth Hot Springs, which is five miles from the nearest gateway community, Gardiner, Montana. Housing costs in Gardiner and the surrounding area have risen sharply in recent years, with the average home price in Gardiner being in the \$850,000 range. Consequently, few of the park's employees can afford to live outside the park. Housing inside the park is scarce and often in poor condition, although we are in the midst of a multi-year effort to improve existing housing. However, the park does not contain enough housing to accommodate the approximately 800 year-round employees necessary for park operations. The housing shortage has negatively impacted our ability to attract qualified employees to fill permanent positions. As a result, YNP is proposing to increase employee housing units in a variety of locations and configurations in the coming years, including in the Lower Mammoth area.

The proposed housing would be four three-bedrooms and two-bathroom modular housing units with garages. Three of the units would be grouped together on Powerhouse Road. The fourth unit would be added to top of Lower Mammoth Service Road. The houses would be 28-feet by 56-feet. The exterior finishes will be similar to modulars installed across the park in recent years: traditional design with timber accents and neutral browns in color. Exterior lights would be "down" lighting as to help protect night skies. Work would include sewer, water, power telecoms, and associated street improvements. Staging would occur in the Mammoth boneyard.

All four of the proposed houses would be in the Lower Mammoth area which is part of which is contributing to the Mammoth Hot Springs Historic District (48YE486). Three of the units would also be in view of the North Entrance Road Historic District (48YE822). YNP Cultural Resources staff determined that the proposed housing units would not constitute an adverse effect to the historic properties within the area of potential effects. Wyoming SHPO concurred with these findings on February 5, 2025. See Internal Documents for correspondence.

YNP biologists determined that the proposed work would have no effect to species protected by the endangered species act. There is no presence of whitebark pine, it is not lynx critical habitat, and there are no records of lynx or wolverine. The project area is within the development footprint of Mammoth managed for humans, not grizzly bears.

The proposed work would be performed by independent contractors and would begin in spring 2025.

Additional compliance action would be needed if utilities need to be moved outside of the proposed area of impact.

Project Locations:

Location

County: Park

State: MT

District:

Section:

Geo. Marker:

Other:

Tract ID:

Funding
Source(s):
PMIS
Number(s):

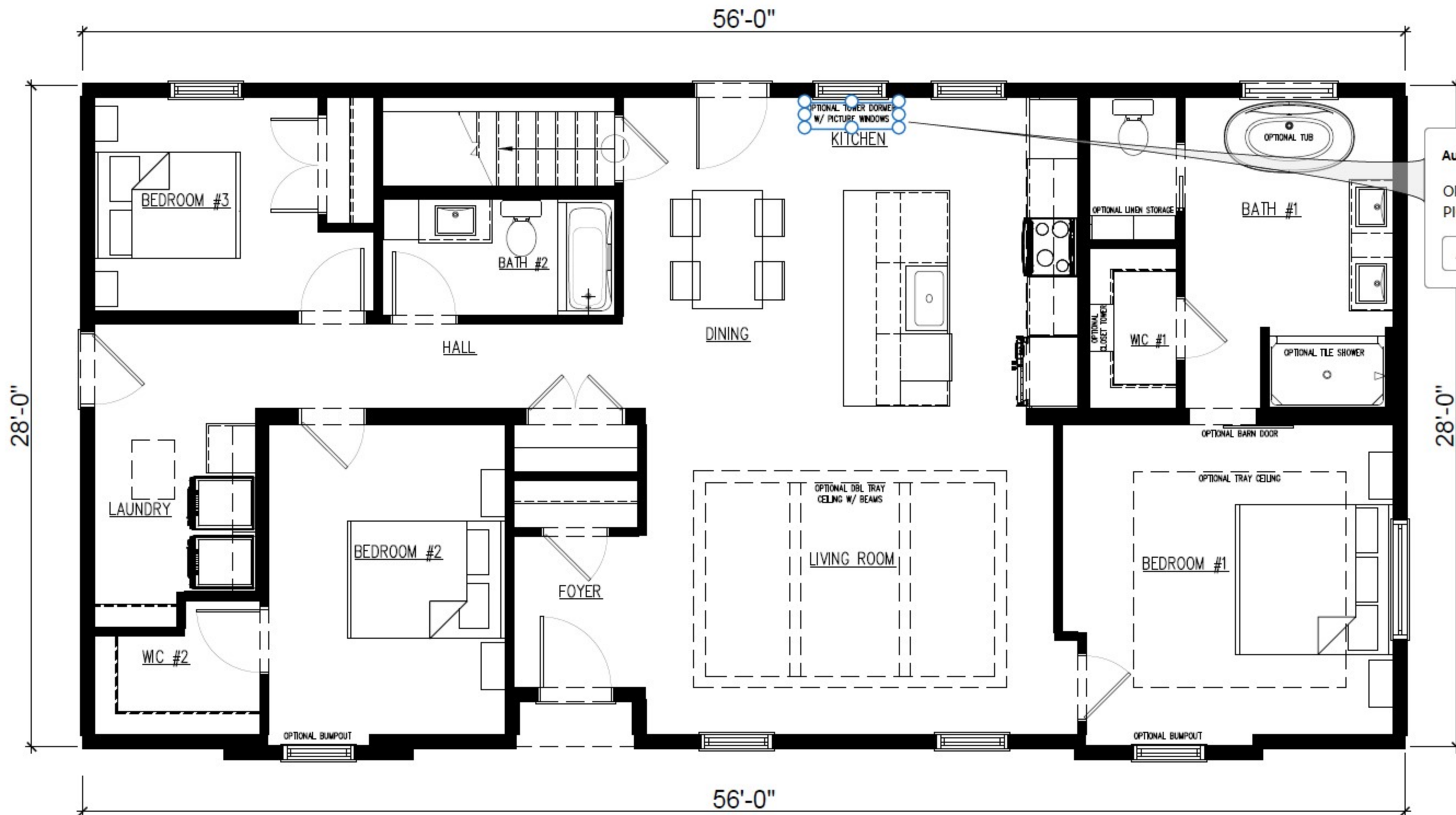
Mitigation(s):
(the following is a complete list of all mitigations that will be incorporated into the above-referenced project)

- **Park Operations & Mgmt - Communications :** Park staff must be notified of implementation prior to commencement of project activities. Local residents, Little People's Learning Center, Snoopy School, persons associated with the Mammoth Community Center, and relevant NPS staff should be notified of construction timelines, road closures, power or water disruptions, and material and equipment staging locations.
- **Wildlife :** To avoid impacts to migratory birds during nesting season, please consider conducting all vegetation removal activities outside of March 1 - August 15th for raptors, and May 1 - August 15th for songbirds. If you are within the March 1 - August 15 window, and you suspect active nests from detection of physical structures (e.g. large collections of sticks or smaller plant material in nest-like shape, cavity holes) or behaviors (e.g. birds in and out of tree cavities, activity at nest-like structures in trees, birds carrying food into nest-like structures), please contact the Bird Program Manager david_b_haines@nps.gov to discuss or schedule a survey.
- **Human Health & Safety :** Line locates must be completed before any excavation work may begin. The depth of utility line varies and there may be multiple utility lines in a common area. Digging without calling can disrupt service, harm you and those around you and potentially result in fines and repair costs. Calling 811 before every job gets underground utility lines marked for free and helps prevent undesired consequences.
- **Night Sky :** Project shall comply with NPS and park lighting guidelines to reduce impacts to the night sky and wildlife. This will include, but is not limited to, low-level lighting, minimized glare, downward focused light fixtures, and energy efficient light sources such as low-pressure sodium lamps.
- **Other :** Please contact your compliance representative if the scope of work changes to ensure proper compliance documentation has been completed. Upon project completion, please send a written summary, with photos if possible, to close out the administrative record for your project.
- **Other :** All material brought into the park from outside sources must be certified weed-free fill obtained from a recently certified facility. Please contact to Yellowstone Center for Resources for the most up to date list of certified facilities in the GYE.
- **Other :** To minimize the amount of ground disturbance, staging and stockpiling areas would be located in previously disturbed sites if at all possible. All staging and stockpiling areas would be returned to pre-construction conditions following construction. Construction zones and staging areas would be identified and fenced with construction tape, snow fencing, or some similar material prior to any construction activity. The fencing would define the construction zone and confine activity to the minimum area required for construction.
- **Park Operations & Mgmt - Construction General :** Contractors would coordinate with park staff to reduce disruption in normal park activities (i.e. facilitate emergency traffic, and hauling material, to allow for visitor use in areas where no conflicts or safety concerns exist).
- **Park Operations & Mgmt - Construction General :** To the extent practical, work shall be scheduled to avoid construction activity and construction related delays during peak visitation times. No holiday or night time work shall be allowed. Weekend work (Friday through Sunday) shall not be allowed unless authorized in writing by the park's Superintendent.
- **Rare, Threatened & Endangered Species :** The project lead will ensure that all project-related employees, such as contract employees, would be given orientation on how to avoid disturbing or encountering bears and how to minimize unavoidable effects or encounters. Orientation would include information about park regulations regarding food storage, disposal of garbage and other bear attractants, and approaching or harassing wildlife.
- **Rare, Threatened & Endangered Species :** Ensure work crews adhere to bear safety and food storage regulations.
- **Soils, Topography, Geology - Disturbance :** To minimize the amount of ground disturbance, staging and stockpiling areas shall be located in previously disturbed sites, away from visitor use areas to the greatest extent possible. All staging and stockpiling areas shall be returned to pre-construction conditions following construction.

- Soils, Topography, Geology - Erosion Controls : All erosion and sediment control devices shall be adequately maintained to assure continued performance of their intended function. Those that have sustained damage or have reached their capability shall be replaced or maintenance performed.
- Vegetation - Weed/Seed Free : All equipment and tools shall be cleaned completely prior to entering the work zone to prevent the spreading of non-invasive plant seeds. Equipment shall be inspected for compliance.
- Assessment of Effect - NAGPRA : In the event that human remains are discovered during fuels reduction activities, all activities in the vicinity of the discovery must stop and the Park Archeologist, Branch Chief of Cultural Resources, NPS Supervisory LE Ranger for Mammoth contacted immediately. If the remains are determined to have no forensic value and are of Native American or Native Hawaiian descent or an historical person, all provisions outlined in the Native American Graves Protection and Repatriation Act (1990), as amended, will be followed.
- Assessment of Effect - Archaeology : If previously unknown archeological or paleontological resources are discovered during construction activities, all ground disturbing activities in the immediate vicinity (300 feet) of the discovery shall be halted and the Park Archaeologist notified immediately. Cultural resources will be identified and documented by an archaeologist meeting the NPS Qualification Standards and the Secretary of the Interior's Professional Qualification Standards. An appropriate mitigation strategy will be developed, if necessary, in accordance with pertinent laws and regulations.

Recommendations for Conditions or Stipulations:

If any previously unidentified cultural materials are discovered during construction, work in the area shall halt immediately, the federal agency and SHPO staff be contacted, and the materials be evaluated by an archaeologist or historian meeting the Secretary of the Interior's Professional Qualification Standards (48 FR 22716, Sept. 1983).



AutoCAD SHX T

OPTIONAL TO
PICTURE WIN

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PAGE:

A1.1



203 Industrial Drive
Redwood Falls, MN
Ph: (507) 644-6600
Fx: (507) 644-6601

MAIN LEVEL FLOOR PLAN

NSXXXX

DRAWN BY: X

DATE: 2024

DEALER: NORTHSTAR SYSTEMBUILT

CUSTOMER: YUKON

REV: X BY: X

DATE: X

SCALE: 1/4"=1'-0"

10/21/2024 8:21 AM C:\p\working\mmd\3\mmd\185708700_mammoth_concept\fig_10-28-2024.dwg



LEGEND

- STANDARD UNIT
- ACCESSIBLE UNIT
- ASPHALT DRIVEWAY
- SIDEWALK
- EXISTING ROADWAY
- EXISTING WATER UTILITIES
- EXISTING WASTEWATER UTILITIES
- EXISTING ELECTRICAL UTILITIES
- PROPOSED WATER UTILITIES (DEPICTION)
- PROPOSED WASTEWATER UTILITIES (DEPICTION)
- PROPOSED ELECTRICAL UTILITIES (DEPICTION)
- PROPOSED TELECOM UTILITIES (DEPICTION)
- EXISTING MAJOR CONTOURS
- EXISTING MINOR CONTOURS
- S NEEDLE PINE TREE
- WETLAND AREA LIMITS

ITEM	QUANTITY
MODULAR UNITS	4
PARKING SPACES	8
NEW ASPHALT PAVING (SF)	2,352
APPROX WETLAND IMPACT AREA (AC)	N/A



DESIGNED: STARTED: BY: TECH. REVIEW: DATE: 12/9/24	SUB SHEET NO. C3.2	TITLE OF SHEET MAMMOTH PREFERED ALTERNATIVE MAMMOTH MODULAR UNIT/RV SITES YELLOWSTONE NATIONAL PARK	DRAWING NO. YELL 101/192110 PMS/PKG NO. 3261414/326104 SHEET 2 OF 3

Lower Mammoth

Potential Housing Sites



North

0 25 50 100 Meters

0 50 100 200 300 Feet

Approximate Construction Area	Rare Plants	Archeology Sites & Historic Districts	National Register of Historic Places
Approx. Construction Area - 33 foot buffer	Wetlands	Grizzly Bear Conservation Strategy Boundary	Historic District
			Landmark

Yellowstone Center for Resources
Spatial Analysis Center
7/22/2024

Project Title: Northeast Entrance Modular Housing (Replace Obsolete Trailers)
Milestones# 2023-165

PEPC Project Number: 120137

Recommended by the following compliance specialists:

NEPA - Compliance Branch Chief

Digital Signature:

CHRISTINE
GABRIEL

Digitally signed by CHRISTINE
GABRIEL
Date: 2025.08.05 09:32:44 -06'00'

NHPA - Cultural Resources Branch Chief

Digital Signature:

TOBIN ROOP

Digitally signed by TOBIN ROOP
Date: 2025.08.07 09:11:22 -06'00'

Compliance Package Prepared By: Bonnie McDonald

Superintendent Review and Approval

The Environmental Screening Form has been reviewed.

AND

The Assessment of Actions Having an Effect on Historic Properties has been reviewed. The proposed work conforms to the *NPS Management Policies* and *Cultural Resource Management Guideline*, and I have reviewed and approve the recommendations, stipulations, or conditions noted in Section C of this form.

AND

The Categorical Exclusion has been reviewed. Decision: I find that the action fits within the categorical exclusion below. Therefore, I am categorically excluding the described project from further NEPA analysis. No extraordinary circumstances apply.

Superintendent Approval

Digital Signature:

CAMERON
SHOLLY

Digitally signed by CAMERON
SHOLLY
Date: 2025.08.11 07:37:56 -06'00'



Categorical Exclusion Documentation Form (CE Form)

Project: Northeast Entrance Modular Housing (Replace Obsolete Trailers)

PEPC Project Number: 120137

Description of Action (Project Description):

Yellowstone National Park (YNP) is located in a remote area, with employees stationed and housed in developed areas throughout the park. The Northeast Entrance administrative area is approximately 49 miles from YNP headquarters in Mammoth Hot Springs, WY. YNP proposes to replace obsolete and previously removed 1970s mobile trailer units with two 2-bedroom modular housing units. The new units are needed in order to correct the health and safety, accessibility, environmental, deferred maintenance, and quality of life deficiencies within the parks housing accommodations.

This categorical exclusion revises the categorical exclusion (PEPC 102533) approved in May 2021 due to project changes and species recently listed under the protection of the Endangered Species Act.

The proposed project would occur in Park County, MT, within Yellowstone National Park, in a portion of the Northeast Entrance administrative area (44°0'18.65"N, 110°0'44.45"W). The 2-bedroom, 2-bathroom modular units would be 28-feet-wide by 40-feet-long with an 8-foot-deep covered porch (see attached photo and drawings). The modulares would be similar to those installed across the park in recent years; traditional design with timber accents, brown in color (see attached design). Work would include sewer, water, power telecoms and associated street improvements. All staging would be on hard surfaces (existing roads and parking areas) within the Northeast Entrance Administrative Area. The work would be done by independent contractors beginning in May 2026.

YNP Cultural Resources staff reviewed the proposed action. The area of potential effect is located within the Northeast Entrance Administrative Area north of the Northeast Entrance Road Historic District (48YE821) and the Northeast Entrance Station National Historic Landmark (48YE709). The proposed new modular housing units would not be visible from these nearby historic properties. Archaeological inventory efforts in 1983 identified no archaeological resources within the area of potential effect. In May 2021, MT SHPO concurred with NPS staff determination that the proposed action would have no adverse effect to any historic properties (see correspondence under PEPC 10253).

USFWS concurred with YNP's determination that the Project 'may affect but is not likely to adversely affect the Canada lynx, and the grizzly bear, is 'not likely to jeopardize the continued existence of the monarch butterfly and the Suckleys cuckoo bumble bee, would have 'no effect on the North American wolverine, the yellow-billed cuckoo, and the Ute ladies-tresses, and 'would not destroy or adversely modify designated Canada lynx critical habitat. The Services biological opinion states that the Project is not likely to jeopardize the continued existence of the whitebark pine with the incorporation of conservation measures. The anticipated level of whitebark pine removal caused by the proposed action would not appreciably reduce the overall population, reproduction, and distribution of whitebark pine throughout its range. See attachments within Other Compliance.

Project Locations:

Location

County:	Park	State:	MT

Mitigation(s):

- All erosion and sediment control devices shall be adequately maintained to assure continued performance of their intended function. Those that have sustained damage or have reached their capability shall be replaced or maintenance performed. (This General Conservation Measure was specified in USFWS Biological Opinion).
- All equipment and tools shall be cleaned completely prior to entering the work zone to prevent the spreading of non-invasive plant seeds. Equipment shall be inspected for compliance. (This General Conservation Measure was specified in USFWS Biological Opinion).
- All material brought into the park from outside sources must be certified weed-free fill obtained from a recently certified facility. Please contact the Yellowstone Center for Resources (YCR) for the most up to date list of certified facilities in the GYE. (This General Conservation Measure was specified in USFWS Biological Opinion).
- To minimize the amount of ground disturbance, staging and stockpiling areas would be located in previously disturbed sites if at all possible. All staging and stockpiling areas would be returned to pre-construction conditions following construction. Construction zones and staging areas would be identified and fenced with construction tape, snow fencing, or some similar material prior to any construction activity. The fencing would define the construction zone and confine activity to the minimum area required for construction. (This General Conservation Measure was specified in USFWS Biological Opinion).
- Project shall comply with NPS and YNP lighting guidelines to reduce impacts to the night sky and wildlife. This will include, but is not limited to, low-level lighting, minimized glare, downward focused light fixtures, and energy efficient light sources such as low pressure sodium lamps. (This General Conservation Measure was specified in USFWS Biological Opinion).
- Ground disturbance from heavy equipment will be avoided within whitebark pine stands and within 10 meters (m; 33 feet) of known whitebark pine trees, which will protect the roots and soil within the drip line of large, mature trees. (This Whitebark Pine Conservation Measure was specified in USFWS Biological Opinion).
- If using heavy equipment in whitebark pine stands cannot be avoided, equipment will be used sparingly and will be cleaned before entering and leaving work sites to prevent the spread of invasive species, pathogens, and pests. (This Whitebark Pine Conservation Measure was specified in USFWS Biological Opinion).
- Pre-project surveys will be conducted to identify whitebark pine individuals of all age classes. (This Whitebark Pine Conservation Measure was specified in USFWS Biological Opinion).
- When marking is appropriate, clusters of whitebark pine trees will be marked (for avoidance) in a manner that does not cause damage to the tree or introduce disease. (This Whitebark Pine Conservation Measure was specified in USFWS Biological Opinion).
- Off road motorized travel in whitebark pine habitat will be avoided. (This Whitebark Pine Conservation Measure was specified in USFWS Biological Opinion).
- When working in whitebark pine stands, work will not introduce or spread *Ribes* species that are an alternate host for white pine blister rust. (This Whitebark Pine Conservation Measure was specified in USFWS Biological Opinion).
- Herbicide spot treatments for infrastructure activities will maintain a minimum distance of 1 m (3.3 feet) from a whitebark pine tree. Ground-based broadcast applications will maintain a minimum distance of 3 m (10 feet) from the trunk of a whitebark pine tree. (This Whitebark Pine Conservation Measure was specified in USFWS Biological Opinion).
- Train project personnel to identify the species regardless of their age class (seedling, sapling, and mature trees) to ensure project activities do not result in more adverse effects than described in the project description. (This Whitebark Pine Conservation Measure was specified in USFWS Biological Opinion).
- Wherever possible, avoid removing or damaging healthy, unsuppressed whitebark trees. Limit soil disturbance and compaction by limiting the use of mechanical equipment such as heavy equipment and vehicles. Control runoff of soil during project activities and avoid using machinery in wet soils and areas prone to ruts. (This Whitebark Pine Conservation Measure was specified in USFWS Biological Opinion).
- To avoid impacts to migratory birds during nesting season, please consider conducting all vegetation removal activities outside of March 1 - August 15th for raptors, and May 1 - August 15th for songbirds. If you are within the March 1 - August 15 window, and you suspect active nests from detection of physical structures (e.g. large collections of sticks or smaller plant material in nest-like shape, cavity holes) or behaviors (e.g. birds in and out of tree cavities, activity at nest-like structures in trees, birds carrying food into nest-like structures), please contact the Bird Program Manager at 307-344-2218 or david_b_haines@nps.gov to discuss or schedule a survey.
- Any and all historic objects discovered during this project (i.e. under foundations, in wall, attic, or crawl spaces, etc.) remain property of the federal government and shall be considered by the YELL Collections Committee for

accessioning into the park unit's museum collection whether they are stored at an NPS facility or placed on loan to an agreed upon repository.

- Line locates must be completed before any excavation work may begin. The depth of utility line varies and there may be multiple utility lines in a common area. Digging without calling can disrupt service, harm you and those around you and potentially result in fines and repair costs. Calling 811 before every job gets underground utility lines marked for free and helps prevent undesired consequences.
- Project shall comply with NPS and park lighting guidelines to reduce impacts to the night sky and wildlife. This will include, but is not limited to, low-level lighting, minimized glare, downward focused light fixtures, and energy efficient light sources such as low-pressure sodium lamps.
- Please contact your compliance representative if the scope of work changes to ensure proper compliance documentation has been completed. Upon project completion, please send a written summary, with photos if possible, to close out the administrative record for your project.
- All material brought into the park from outside sources must be certified weed-free fill obtained from a recently certified facility. Please contact The Yellowstone Center for Resources for the most up to date list of certified facilities in the GYE.
- To minimize the amount of ground disturbance, staging and stockpiling areas would be located in previously disturbed sites if at all possible. All staging and stockpiling areas would be returned to pre-construction conditions following construction. Construction zones and staging areas would be identified and fenced with construction tape, snow fencing, or some similar material prior to any construction activity. The fencing would define the construction zone and confine activity to the minimum area required for construction.
- Contractors would coordinate with park staff to reduce disruption in normal park activities (i.e. facilitate emergency traffic, and hauling material, to allow for visitor use in areas where no conflicts or safety concerns exist)
- Project manager will ensure residents are properly notified of project related activities including closures, detours, power outages, and invasive plant treatment as necessary, prior to commencement of the aforementioned activities.
- To the extent practical, work shall be scheduled to avoid construction activity and construction related delays during peak visitation times. No holiday or night time work shall be allowed. Weekend work (Friday through Sunday) shall not be allowed unless authorized in writing by the park's Superintendent.
- The project lead will ensure that all project-related employees, such as contract employees, would be given orientation on how to avoid disturbing or encountering bears and how to minimize unavoidable effects or encounters. Orientation would include information about park regulations regarding food storage, disposal of garbage and other bear attractants, and approaching or harassing wildlife.
- Ensure work crews adhere to bear safety and food storage regulations.
- If previously unknown archeological or paleontological resources are discovered during construction activities, all ground disturbing activities in the immediate vicinity (300 feet) of the discovery shall be halted and the Park Archaeologist notified immediately. Cultural resources will be identified and documented by an archaeologist meeting the NPS Qualification Standards and the Secretary of the Interior's Professional Qualification Standards. An appropriate mitigation strategy will be developed, if necessary, in accordance with pertinent laws and regulations.
- In the event that human remains are discovered during fuels reduction activities, all activities in the vicinity of the discovery must stop and the Park Archeologist, Branch Chief of Cultural Resources, NPS Supervisory LE Ranger for Grant contacted immediately. If the remains are determined to have no forensic value and are of Native American or Native Hawaiian descent or an historical person, all provisions outlined in the Native American Graves Protection and Repatriation Act (1990), as amended, will be followed. Comment:

CE Citation: 3.3.C.18 Construction of minor structures, including small improved parking lots, in previously disturbed or developed areas.

CE Justification:

This project proposes replaces obsolete employee housing trailers with new modular housing units. Replacement activity would occur within a developed/previously disturbed employee housing area. There would be no significant impact to natural or cultural resources by the project as proposed, providing mitigation measures are followed. Therefore, Categorical Exclusion 3.3.C.18 applies.

Decision: I find that the action fits within the categorical exclusion above. Therefore, I am categorically excluding the described project from further NEPA analysis. No extraordinary circumstances apply.

Extraordinary Circumstances:

If implemented, would the proposal...	Yes/No	Explanation
A. Have significant impacts on public health or safety?	No	This project which proposes to replace badly deteriorated housing trailers with new modular housing would not have significant negative impacts to public health and safety. In fact, this project would have positive impacts to employee health and safety: the removal of the deteriorating trailers which is a health hazard and the installation of new modular housing.
B. Have significant impacts on such natural resources and unique geographic characteristics as historic or cultural resources; park, recreation or refuge lands; wilderness areas; wild or scenic rivers; national natural landmarks; sole or principal drinking water aquifers; prime farmlands; wetlands; floodplains; national monuments; migratory birds; and other ecologically significant or critical areas?	No	This proposed project occurs within a previously disturbed area within the Northeast Entrance administrative area. It would not have significant impacts on natural or cultural resources. It would occur outside the recommended wilderness boundary. It does not have impacts to wild or scenic rivers, landmarks, wetlands, floodplains, national monuments, migratory birds or ecologically critical or significant areas.
C. Have highly uncertain and potentially significant environmental effects or involve unique or unknown environmental risks?	No	This circumstance does not apply because the project is occurring within the footprint of previous disturbance (the replacement of badly deteriorated NPS employee housing trailers with new modular housing). The proposed project does not have highly uncertain or potentially significant environmental impacts or risks.
D. Establish a precedent for future action or represent a decision in principle about future actions with potentially significant environmental effects?	No	This project does not establish a precedent for future action because potential future projects with similar scope are unlikely to have the potential for significant environmental effects. The replacement of badly deteriorated buildings is a sustainable mechanism to address shifting park needs while limiting the expansion of developed areas and the overall building footprint parkwide.
E. Have a direct relationship to other actions that implicate potentially significant environmental effects?	No	This extraordinary circumstance does not apply because the project is within the previous disturbance Northeast Entrance Administrative Area housing development. This project which proposes to replace badly deteriorating housing trailers with new modular housing, so no new area would be disturbed and thus no new cumulatively significant environmental effects.
F. Have significant impacts on properties listed, or eligible for listing, on the National Register of Historic Places as determined by the bureau?	No	In 2021 WYSHPO concurred with Yellowstone National Park Cultural Resources staff that the proposed action would have no adverse effects to historic places. The 2021 Sec 106 letter remains in effect, with no historic properties being impacted by the proposed action. See PEPC 10253.
G. Have significant impacts on species listed, or proposed to be listed, on the List of Endangered or Threatened Species or have significant impacts on designated Critical Habitat for these species?	No	See description under Other Compliance and USFWS documentation attached within Internal Documents.
H. Significantly limit access to and ceremonial use of Indian sacred sites on Federal lands by Indian religious practitioners or significantly adversely affect the physical integrity of such sacred sites?	No	This is not applicable because access to and ceremonial use of indigenous sacred sites would not be limited.

I. Contribute to potentially significant effects resulting from the introduction, continued existence, or spread of noxious weeds or non-native invasive species known to occur in the area or from other actions that promote the introduction, growth, or expansion of the range of such species (Federal Noxious Weed Control Act)?	No	This project would not contribute to the introduction or spread of noxious weeds or nonnative invasive species because ground disturbance associated with the project would be minimal, and mitigations are in place to limit the spread of such vegetation.



ENVIRONMENTAL SCREENING FORM (ESF)

Updated Sept 2015 per NPS NEPA Handbook

A. PROJECT INFORMATION

Project Title: Northeast Entrance Modular Housing (Replace Obsolete Trailers)
PEPC Project Number: 120137
PMIS Number:
Project Type: Reconstruction (REC)
Project Location:
County, State: Park, Montana
Project Leader: Robert Kammel

B. PROJECT DESCRIPTION

Yellowstone National Park (YNP) is located in a remote area, with employees stationed and housed in developed areas throughout the park. The Northeast Entrance administrative area is approximately 49 miles from YNP headquarters in Mammoth Hot Springs, WY. YNP proposes to replace obsolete and previously removed 1970s mobile trailer units with two 2-bedroom modular housing units. The new units are needed in order to correct the health and safety, accessibility, environmental, deferred maintenance, and quality of life deficiencies within the parks housing accommodations.

This categorical exclusion revises the categorical exclusion (PEPC 102533) approved in May 2021 due to project changes and species recently listed under the protection of the Endangered Species Act.

The proposed project would occur in Park County, MT, within Yellowstone National Park, in a portion of the Northeast Entrance administrative area (44°0'18.65"N, 110°0'44.45"W). The 2-bedroom, 2-bathroom modular units would be 28-feet-wide by 40-feet-long with an 8-foot-deep covered porch (see attached photo and drawings). The modulares would be similar to those installed across the park in recent years; traditional design with timber accents, brown in color (see attached design). Work would include sewer, water, power telecoms and associated street improvements. All staging would be on hard surfaces (existing roads and parking areas) within the Northeast Entrance Administrative Area. The work would be done by independent contractors beginning in May 2026.

YNP Cultural Resources staff reviewed the proposed action. The area of potential effect is located within the Northeast Entrance Administrative Area north of the Northeast Entrance Road Historic District (48YE821) and the Northeast Entrance Station National Historic Landmark (48YE709). The proposed new modular housing units would not be visible from these nearby historic properties. Archaeological inventory efforts in 1983 identified no archaeological resources within the area of potential effect. In May 2021, MT SHPO concurred with NPS staff determination that the proposed action would have no adverse effect to any historic properties (see correspondence under PEPC 102533).

USFWS concurred with YNP's determination that the Project 'may affect but is not likely to adversely affect the Canada lynx, and the grizzly bear, is 'not likely to jeopardize the continued existence of the monarch butterfly and the Suckleys cuckoo bumble bee, would have 'no effect on the North American wolverine, the yellow-billed cuckoo, and the Ute ladies-tresses, and 'would not destroy or adversely modify designated Canada lynx critical habitat. The Services biological opinion states that the Project is not likely to jeopardize the continued existence of the whitebark pine with the incorporation of conservation measures. The anticipated level of whitebark pine removal caused by the proposed action would not appreciably

reduce the overall population, reproduction, and distribution of whitebark pine throughout its range. See attachments within Other Compliance.

C. RESOURCE IMPACTS TO CONSIDER:

Resource	Potential for Impact	Potential Issues & Impacts
Air Air Quality <i>Air Quality</i>	Potential	Issue: Exhaust and dust generated from construction activities and equipment Impact: Air quality would be temporarily degraded due to construction dust during the construction period. Local emissions from construction equipment would occur during this same time.
Biological Nonnative or Exotic Species <i>Nonnative plants</i>	Potential	Issue: Spread or introduction of nonnative plants Impact: Nonnative plants may be spread or introduced during ground-disturbing activities or by equipment travel from one area to another. Equipment would be washed before and after working in the area to minimize potential spread of weed seed.
Biological Species of Special Concern or Their Habitat <i>Species protected by the Endangered Species Act</i>	Potential	Issue: Species protected by the Endangered Species Act could occur within the action area Impact: USFWS concurred with YNP's determination that the Project 'may affect but is not likely to adversely affect the Canada lynx, (<i>Lynx canadensis</i>) and the grizzly bear (<i>Ursus arctos</i>), is 'not likely to jeopardize the continued existence of the monarch butterfly (<i>Danaus plexippus</i>) and the Suckleys cuckoo bumble bee (<i>Bombus suckleyi</i>), will have 'no effect on the North American wolverine (<i>Gulo gulo luscus</i>), the yellow-billed cuckoo (<i>Coccyzus americanus</i>), and the Ute ladies-tresses (<i>Spiranthes diluvialis</i>), and 'will not destroy or adversely modify designated Canada lynx critical habitat. The Services biological opinion states that the Project is not likely to jeopardize the continued existence of the whitebark pine with the incorporation of conservation measures. The anticipated level of whitebark pine removal caused by the proposed action will not appreciably reduce the overall population, reproduction, and distribution of whitebark pine throughout its range.
Biological Vegetation <i>Forest</i>	Potential	Issue: The removal of some trees could be required to install utilities and the modular homes. Impact: Forests cover roughly 80% of Yellowstone National Park so the removal of trees within the proposed project area would have a small impact on the overall forests of Yellowstone.
Biological Wildlife and/or Wildlife Habitat including terrestrial and aquatic species <i>Wildlife habitat</i>	Potential	Issue: Tree removal would be required to install utilities and the modular homes. Impact: Removal of some trees would negatively impact the micro-ecosystem dependent on those trees (insects, small mammals) until they were able to move to a nearby tree.
Cultural Archeological	Potential	Issue: Archeological resources are well documented within development areas. Although unlikely, ground disturbance during construction may uncover previously unknown archaeological resources. Mitigation measures would be in

Resources <i>Archeological</i>		place to address inadvertent discovery and minimize any potential resource impacts in areas that do not have surface archaeological resources.
Cultural Cultural Landscapes <i>Historic District</i>	Potential	Issue: Recommend maintain vegetation/tree screening to obscure the residential area from the Northeast Entrance Road Historic District to maintain the character of setting to avoid adverse effect to the Northeast Entrance Road Historic District.
Cultural Ethnographic Resources <i>Ethnographic Resources</i>	None	Impact: Tribes have identified all of YNP as containing ethnographic resources, however, none specific to the current project area have been identified. If ethnographic resource concerns are identified additional consultation will be needed.
Cultural Museum Collections <i>Objects and Specimens</i>	Potential	Issue: Ground disturbance associated with this project could expose previously unknown objects or specimens of interest by Yellowstone National Park museum staff. Impact: Ground disturbance work could damage or destroy previously unknown resources. However, mitigations are in place if such resources are found during work.
Cultural Prehistoric/historic structures	None	
Geological Geologic Features <i>Soils</i>	Potential	Issue: Ground disturbance would be necessary for this project. Impact: Minor, short-and long-term impacts would occur to the geological resources in the project area due to excavation necessary to perform this project. This is a previously disturbed (housing) area. Mitigations are in place in the event that cultural resources are found during excavation.
Geological Geologic Processes	None	
Lightscapes Lightscapes <i>Night skies</i>	Potential	Issue: Increased housing capacity and number of light sources Impact: Increasing housing capacity in the park would inherently increase the number of light sources available to contribute to the degradation of night skies. However, it is not expected that the implementation of this project would degrade the quality of night sky in the park to a point where it would be noticeably apparent.
Other Human Health and Safety <i>Employee health and safety</i>	Potential	Issue: Old housing units were infested with pests and badly deteriorated Impact: The health and safety of employees living in park housing would be greatly improved by removing the old trailer units and installing new modular housing.
Paleontological Paleontological Resources	None	
Socioeconomic Land Use <i>Land Use</i>	None	Impact: There is no change in land use with this proposed action.

Socioeconomic Socioeconomic <i>Socioeconomic factors</i>	None	Impact: There would be no change to socioeconomic factors with this proposed action.
Soundscapes Soundscapes <i>Natural soundscapes</i>	Potential	Issue: Construction noise Impact: There would be noise generated by construction activities at the site; however, the area is developed and some human-generated noise is already present. The impacts would be temporary and limited to daylight hours.
Viewsheds Viewsheds	None	
Visitor Use and Experience Recreation Resources <i>Recreation Resources, NPS Staff</i>	Potential	Issue: New modular housing replaces outdated, unsafe trailer housing Impact: The availability of safe, secure, and comfortable NPS-staff housing would help Yellowstone National Park maintain its workforce which would help keep the Park at a higher level of service for visitors.
Visitor Use and Experience Visitor Use and Experience	None	
Water Floodplains	None	
Water Water Quality or Quantity <i>Water Quality</i>	Potential	Issue: Temporary water (rain, snow-melt runoff) turbidity during ground disturbance. Impact: Negligible short-and long-term adverse impacts to water quality may occur during ground disturbance activities. Mitigations are in place to reduce/prevent the runoff of turbid water during rain events.
Water Wetlands <i>Wetlands</i>	None	Impact: No wetlands would be impacted by this proposed action. Site surveyed by YNP Botanist, Heidi Anderson.
Wilderness Wilderness	None	

D. ESF ADDENDUM QUESTIONS:

Question	Answer	Notes



ASSESSMENT OF ACTIONS HAVING AN EFFECT ON HISTORIC PROPERTIES

A. DESCRIPTION OF UNDERTAKING

1. Park: Yellowstone National Park

2. Project Description:

Project Name: Northeast Entrance Modular Housing (Replace Obsolete Trailers)

Prepared by: Elizabeth Horton **Date Prepared:** **Telephone:** (307) 344-2290

PEPC Project Number: 120137

Locations:

County, State: Park, MT

Describe project:

Yellowstone National Park (YNP) is located in a remote area, with employees stationed and housed in developed areas throughout the park. The Northeast Entrance administrative area is approximately 49 miles from YNP headquarters in Mammoth Hot Springs, WY. YNP proposes to replace obsolete and previously removed 1970s mobile trailer units with two 2-bedroom modular housing units. The new units are needed in order to correct the health and safety, accessibility, environmental, deferred maintenance, and quality of life deficiencies within the parks housing accommodations.

This categorical exclusion revises the categorical exclusion (PEPC 102533) approved in May 2021 due to project changes and species recently listed under the protection of the Endangered Species Act.

The proposed project would occur in Park County, MT, within Yellowstone National Park, in a portion of the Northeast Entrance administrative area (44°0'18.65"N, 110°0'44.45"W). The 2-bedroom, 2-bathroom modular units would be 28-feet-wide by 40-feet-long with an 8-foot-deep covered porch (see attached photo and drawings). The modulares would be similar to those installed across the park in recent years; traditional design with timber accents, brown in color (see attached design). Work would include sewer, water, power telecoms and associated street improvements. All staging would be on hard surfaces (existing roads and parking areas) within the Northeast Entrance Administrative Area. The work would be done by independent contractors beginning in May 2026.

YNP Cultural Resources staff reviewed the proposed action. The area of potential effect is located within the Northeast Entrance Administrative Area north of the Northeast Entrance Road Historic District (48YE821) and the Northeast Entrance Station National Historic Landmark (48YE709). The proposed new modular housing units would not be visible from these nearby historic properties. Archaeological inventory efforts in 1983 identified no archaeological resources within the area of potential effect. In May 2021, MT SHPO concurred with NPS staff determination that the proposed action would have no adverse effect to any historic properties (see correspondence under PEPC 10253).

USFWS concurred with YNP's determination that the Project 'may affect but is not likely to adversely affect the Canada lynx, and the grizzly bear, is 'not likely to jeopardize the continued existence of the monarch butterfly and the Suckleys cuckoo bumble bee, would have 'no effect on the North American wolverine, the yellow-billed cuckoo, and the Ute ladies-tresses, and 'would not destroy or adversely modify designated Canada lynx critical habitat. The Services biological opinion states that the Project is not likely to jeopardize the continued existence of the whitebark pine with the incorporation of conservation measures. The anticipated level of whitebark pine removal caused by the proposed action would not appreciably reduce the overall population, reproduction, and distribution of whitebark pine throughout its range. See attachments within Other Compliance.

Area of potential effects (as defined in 36 CFR 800.16[d])

(a) The APE (Enclosure 3, Figure 2 in PEPC Project 102533) is located within the existing NPS administrative area north of the Northeast Entrance Road Historic District (48YE821) and the Northeast Entrance Station National Historic Landmark (48YE709). The proposed new modular housing units would not be visible from these nearby historic properties. Archaeological inventory efforts in 1983 identified no archaeological resources within the Area of Potential Effects.

3. Has the area of potential effects been surveyed to identify historic properties?

☐ No

☒ Yes

Source or reference:

4. Potentially Affected Resource(s):

Archeological Resources Present: No

Archeological Resources Notes: The park completed an archaeological survey for this area in 1995. No archaeological resources were identified during pedestrian survey within the proposed housing area site.

Historical Structures/Resources Present: Yes

Historical Structures/Resources Notes: Northeast Entrance Road Historic District (48YE821) and the Northeast Entrance Station National Historic Landmark (48YE709). The proposed new modular housing units would not be visible from these nearby historic properties (check w Alicia)

Cultural Landscapes Present:

Ethnographic Resources Present:

Ethnographic Resources Notes: Tribes have identified all of YNP as containing ethnographic resources, however, none specific to the current project area have been identified. If ethnographic resource concerns are identified additional consultation will be needed.

5. The proposed action will: (check as many as apply)

☐ No Destroy, remove, or alter features/elements from a historic structure

☐ No Replace historic features/elements in kind

☐ No Add non-historic features/elements to a historic structure

☐ No Alter or remove features/elements of a historic setting or environment (inc. terrain)

☐ No Add non-historic features/elements (inc. visual, audible, or atmospheric) to a historic setting or cultural landscape

☐ No Disturb, destroy, or make archeological resources inaccessible

☐ No Disturb, destroy, or make ethnographic resources inaccessible

☐ Yes Potentially affect presently unidentified cultural resources

☐ No Begin or contribute to deterioration of historic features, terrain, setting, landscape elements, or archeological or ethnographic resources

☐ No Involve a real property transaction (exchange, sale, or lease of land or structures)

☐ Other (please specify): _____

6. Supporting Study Data:

(Attach if feasible; if action is in a plan, EA or EIS, give name and project or page number.)

B. REVIEWS BY CULTURAL RESOURCE SPECIALISTS

The park 106 coordinator requested review by the park's cultural resource specialist/advisors as indicated by check-off boxes or as follows:

No Reviews From: Curator, Archeologist, Historical Architect, Historian, 106 Advisor, Other Advisor, Anthropologist, Historical Landscape Architect

C. PARK SECTION 106 COORDINATOR'S REVIEW AND RECOMMENDATIONS

1. Assessment of Effect:

☐	No Potential to Cause Effects
☐	No Historic Properties Affected
☒	No Adverse Effect
☐	Adverse Effect

2. Documentation Method:

☒ Standard 36 CFR Part 800 Consultation

Further consultation under 36 CFR Part 800 is needed.

☐ Streamlined Review Under the 2008 Servicewide Programmatic Agreement (PA)

The above action meets all conditions for a streamlined review under section III of the 2008 Servicewide PA for Section 106 compliance.

☐ Program Comment on Stewardship and Management of National Park Service Mission 66-Era Facilities (1945-1972)

The above action meets all of the requirements of this Program Comment for Section 106 compliance and required documents have been uploaded.

☐ Undertaking Related to Park Specific or Another Agreement

The proposed undertaking is covered for Section 106 purposes under another document such as a park, region or statewide agreement established in accord with 36 CFR 800.7 or 36 CFR 800.14.

3. Consultation Information

SHPO Required: Yes

SHPO Sent: May 6, 2021

SHPO Received: Apr 21, 2021

THPO Required:

THPO Sent:

THPO Received:

SHPO/THPO Notes: Compliance completed in 2021. See PEPC 102533

Advisory Council Participating: No

Advisory Council Notes:

Additional Consulting Parties: No

4. Stipulations and Conditions: Following are listed any stipulations or conditions necessary to ensure that the assessment of effect above is consistent with 36 CFR Part 800 criteria of effect or to avoid or reduce potential adverse effects.

5. Mitigations/Treatment Measures: Measures to prevent or minimize loss or impairment of historic/prehistoric properties: (Remember that setting, location, and use may be relevant.)

Required Mitigations - For the proposed project actions to be within compliance requirements during construction and/or project implementation, the following mitigations must be adhered to:

- All erosion and sediment control devices shall be adequately maintained to assure continued performance of their intended function. Those that have sustained damage or have reached their capability shall be replaced or maintenance performed. (This General Conservation Measure was specified in USFWS Biological Opinion).
- All equipment and tools shall be cleaned completely prior to entering the work zone to prevent the spreading of non-invasive plant seeds. Equipment shall be inspected for compliance. (This General Conservation Measure was specified in USFWS Biological Opinion).
- All material brought into the park from outside sources must be certified weed-free fill obtained from a recently certified facility. Please contact the Yellowstone Center for Resources (YCR) for the most up to date list of certified facilities in the GYE. (This General Conservation Measure was specified in USFWS Biological Opinion).
- To minimize the amount of ground disturbance, staging and stockpiling areas would be located in previously disturbed sites if at all possible. All staging and stockpiling areas would be returned to pre-construction conditions following construction. Construction zones and staging areas would be identified and fenced with construction tape, snow fencing, or some similar material prior to any construction activity. The fencing would define the construction zone and confine activity to the minimum area required for construction. (This General Conservation Measure was specified in USFWS Biological Opinion).
- Project shall comply with NPS and YNP lighting guidelines to reduce impacts to the night sky and wildlife. This will include, but is not limited to, low-level lighting, minimized glare, downward focused light fixtures, and energy efficient light sources such as low pressure sodium lamps. (This General Conservation Measure was specified in USFWS Biological Opinion).
- Ground disturbance from heavy equipment will be avoided within whitebark pine stands and within 10 meters (m; 33 feet) of known whitebark pine trees, which will protect the roots and soil within the drip line of large, mature trees. (This Whitebark Pine Conservation Measure was specified in USFWS Biological Opinion).
- If using heavy equipment in whitebark pine stands cannot be avoided, equipment will be used sparingly and will be cleaned before entering and leaving work sites to prevent the spread of invasive species, pathogens, and pests. (This Whitebark Pine Conservation Measure was specified in USFWS Biological Opinion).
- Pre-project surveys will be conducted to identify whitebark pine individuals of all age classes. (This Whitebark Pine Conservation Measure was specified in USFWS Biological Opinion).
- When marking is appropriate, clusters of whitebark pine trees will be marked (for avoidance) in a manner that does not cause damage to the tree or introduce disease. (This Whitebark Pine Conservation Measure was specified in USFWS Biological Opinion).
- Off road motorized travel in whitebark pine habitat will be avoided. (This Whitebark Pine Conservation Measure was specified in USFWS Biological Opinion).
- When working in whitebark pine stands, work will not introduce or spread *Ribes* species that are an alternate host for white pine blister rust. (This Whitebark Pine Conservation Measure was specified in USFWS Biological Opinion).

- Herbicide spot treatments for infrastructure activities will maintain a minimum distance of 1 m (3.3 feet) from a whitebark pine tree. Ground-based broadcast applications will maintain a minimum distance of 3 m (10 feet) from the trunk of a whitebark pine tree. (This Whitebark Pine Conservation Measure was specified in USFWS Biological Opinion).
- Train project personnel to identify the species regardless of their age class (seedling, sapling, and mature trees) to ensure project activities do not result in more adverse effects than described in the project description. (This Whitebark Pine Conservation Measure was specified in USFWS Biological Opinion).
- Wherever possible, avoid removing or damaging healthy, unsuppressed whitebark trees. Limit soil disturbance and compaction by limiting the use of mechanical equipment such as heavy equipment and vehicles. Control runoff of soil during project activities and avoid using machinery in wet soils and areas prone to ruts. (This Whitebark Pine Conservation Measure was specified in USFWS Biological Opinion).
- To avoid impacts to migratory birds during nesting season, please consider conducting all vegetation removal activities outside of March 1 - August 15th for raptors, and May 1 - August 15th for songbirds. If you are within the March 1 - August 15 window, and you suspect active nests from detection of physical structures (e.g. large collections of sticks or smaller plant material in nest-like shape, cavity holes) or behaviors (e.g. birds in and out of tree cavities, activity at nest-like structures in trees, birds carrying food into nest-like structures), please contact the Bird Program Manager at 307-344-2218 or david_b_haines@nps.gov to discuss or schedule a survey.
- Any and all historic objects discovered during this project (i.e. under foundations, in wall, attic, or crawl spaces, etc.) remain property of the federal government and shall be considered by the YELL Collections Committee for accessioning into the park unit's museum collection whether they are stored at an NPS facility or placed on loan to an agreed upon repository.
- Line locates must be completed before any excavation work may begin. The depth of utility line varies and there may be multiple utility lines in a common area. Digging without calling can disrupt service, harm you and those around you and potentially result in fines and repair costs. Calling 811 before every job gets underground utility lines marked for free and helps prevent undesired consequences.
- Project shall comply with NPS and park lighting guidelines to reduce impacts to the night sky and wildlife. This will include, but is not limited to, low-level lighting, minimized glare, downward focused light fixtures, and energy efficient light sources such as low-pressure sodium lamps.
- Please contact your compliance representative if the scope of work changes to ensure proper compliance documentation has been completed. Upon project completion, please send a written summary, with photos if possible, to close out the administrative record for your project.
- All material brought into the park from outside sources must be certified weed-free fill obtained from a recently certified facility. Please contact The Yellowstone Center for Resources for the most up to date list of certified facilities in the GYE.
- To minimize the amount of ground disturbance, staging and stockpiling areas would be located in previously disturbed sites if at all possible. All staging and stockpiling areas would be returned to pre-construction conditions following construction. Construction zones and staging areas would be identified and fenced with construction tape, snow fencing, or some similar material prior to any construction activity. The fencing would define the construction zone and confine activity to the minimum area required for construction.
- Contractors would coordinate with park staff to reduce disruption in normal park activities (i.e. facilitate emergency traffic, and hauling material, to allow for visitor use in areas where no conflicts or safety concerns exist)
- Project manager will ensure residents are properly notified of project related activities including closures, detours, power outages, and invasive plant treatment as necessary, prior to commencement of the aforementioned activities.
- To the extent practical, work shall be scheduled to avoid construction activity and construction related delays during peak visitation times. No holiday or night time work shall be allowed. Weekend work (Friday through Sunday) shall not be allowed unless authorized in writing by the park's Superintendent.
- The project lead will ensure that all project-related employees, such as contract employees, would be given orientation on how to avoid disturbing or encountering bears and how to minimize unavoidable effects or encounters. Orientation would include information about park regulations regarding food storage, disposal of garbage and other bear attractants, and approaching or harassing wildlife.

- Ensure work crews adhere to bear safety and food storage regulations.
- If previously unknown archeological or paleontological resources are discovered during construction activities, all ground disturbing activities in the immediate vicinity (300 feet) of the discovery shall be halted and the Park Archaeologist notified immediately. Cultural resources will be identified and documented by an archaeologist meeting the NPS Qualification Standards and the Secretary of the Interior's Professional Qualification Standards. An appropriate mitigation strategy will be developed, if necessary, in accordance with pertinent laws and regulations.
- In the event that human remains are discovered during fuels reduction activities, all activities in the vicinity of the discovery must stop and the Park Archeologist, Branch Chief of Cultural Resources, NPS Supervisory LE Ranger for Grant contacted immediately. If the remains are determined to have no forensic value and are of Native American or Native Hawaiian descent or an historical person, all provisions outlined in the Native American Graves Protection and Repatriation Act (1990), as amended, will be followed. Comment:

6. Assessment of Effect Notes:

D. RECOMMENDED BY PARK SECTION 106 COORDINATOR:

E. SUPERINTENDENT'S APPROVAL

The proposed work conforms to the NPS *Management Policies* and *Cultural Resource Management Guideline*, and I have reviewed and approve the recommendations, stipulations, or conditions noted in Section C of this form.



Other Compliance/Consultations Form

Park Name: Yellowstone National Park

PEPC Project Number: 120137

Project Title: Northeast Entrance Modular Housing (Replace Obsolete Trailers)

Project Type: Reconstruction

Project Location:

County, State: Park, MT

Project Leader: Robert Kammel

ESA

Any Federal Species in the project Area? Yes

If species in area: Likely to Adversely Affect

Was Biological Assessment prepared?

If Biological Assessment prepared, concurred? Yes

Formal Consultation required? Yes

Formal Consultation Notes:

The Services biological opinion states that the Project is not likely to jeopardize the continued existence of the whitebark pine with the incorporation of conservation measures. The anticipated level of whitebark pine removal caused by the proposed action will not appreciably reduce the overall population, reproduction, and distribution of whitebark pine throughout its range.

Formal Consultation Concluded:

May 23, 2025

Any State listed Species in the Project Area?

Consultation Information:

USFWS concurred with YNP's determination that the Project 'may affect but is not likely to adversely affect the Canada lynx, (*Lynx canadensis*) and the grizzly bear (*Ursus arctos*), is 'not likely to jeopardize the continued existence of the monarch butterfly (*Danaus plexippus*) and the Suckleys cuckoo bumble bee (*Bombus suckleyi*), will have 'no effect on the North American wolverine (*Gulo gulo luscus*), the yellow-billed cuckoo (*Coccyzus americanus*), and the Ute ladies-tresses (*Spiranthes diluvialis*), and 'will not destroy or adversely modify designated Canada lynx critical habitat.

General Notes:

Data Entered By: Daniel Stahler

Date: Jul 7, 2025

ESA Mitigations

Mitigation ID	Type	Text
187687	Rare, Threatened & Endangered Species	When working in whitebark pine stands, work will not introduce or spread Ribes species that are an alternate host for white pine blister rust. (This Whitebark Pine Conservation Measure was specified in USFWS Biological Opinion).
187690	Rare, Threatened & Endangered Species	Pre-project surveys will be conducted to identify whitebark pine individuals of all age classes. (This Whitebark Pine Conservation Measure was specified in USFWS Biological Opinion).
187691	Rare, Threatened & Endangered Species	If using heavy equipment in whitebark pine stands cannot be avoided, equipment will be used sparingly and will be cleaned before entering and leaving work sites to prevent the spread of invasive species, pathogens, and pests. (This Whitebark Pine Conservation Measure was specified in USFWS Biological Opinion).
175945	Rare, Threatened & Endangered Species	The project lead will ensure that all project-related employees, such as contract employees, would be given orientation on how to avoid disturbing or encountering bears and how to minimize unavoidable effects or encounters. Orientation would include information about park regulations regarding food storage, disposal of garbage and other bear attractants, and approaching or harassing wildlife.
175944	Rare, Threatened & Endangered Species	Ensure work crews adhere to bear safety and food storage regulations.
187686	Rare, Threatened & Endangered Species	Herbicide spot treatments for infrastructure activities will maintain a minimum distance of 1 m (3.3 feet) from a whitebark pine tree. Ground-based broadcast applications will maintain a minimum distance of 3 m (10 feet) from the trunk of a whitebark pine tree. (This Whitebark Pine Conservation Measure was specified in USFWS Biological Opinion).
187684	Rare, Threatened & Endangered Species	Wherever possible, avoid removing or damaging healthy, unsuppressed whitebark trees. Limit soil disturbance and compaction by limiting the use of mechanical equipment such as heavy equipment and vehicles. Control runoff of soil during project activities and avoid using machinery in wet soils and areas prone to ruts. (This Whitebark Pine Conservation Measure was specified in USFWS Biological Opinion).
187685	Rare, Threatened & Endangered Species	Train project personnel to identify the species regardless of their age class (seedling, sapling, and mature trees) to ensure project activities do not result in more adverse effects than described in the project description. (This Whitebark Pine Conservation Measure was specified in USFWS Biological Opinion).
187688	Rare, Threatened & Endangered Species	Off road motorized travel in whitebark pine habitat will be avoided. (This Whitebark Pine Conservation Measure was specified in USFWS Biological Opinion).
187689	Rare, Threatened & Endangered Species	When marking is appropriate, clusters of whitebark pine trees will be marked (for avoidance) in a manner that does not cause damage to the tree or introduce disease. (This Whitebark Pine Conservation Measure was specified in USFWS Biological Opinion).
187692	Rare, Threatened & Endangered Species	Ground disturbance from heavy equipment will be avoided within whitebark pine stands and within 10 meters (m; 33 feet) of known whitebark pine trees, which will protect the roots and soil within the drip line of large, mature trees. (This Whitebark Pine Conservation Measure was specified in USFWS Biological Opinion).

Floodplains/Wetlands/\$404 Permits

Question	Yes	No	Details
A.1. Is project in 100- or 500-year floodplain or flash flood hazard area?		No	Not in floodplain or flash flood hazard area.

A.2. Is Project in wetlands as defined by NPS/DOI?		No	Not in wetland as defined by NPS/DOI.
B. COE Section 404 permit needed?		No	No placement of fill in waters of the United States.
C. State 401 certification?		No	
D. State Section 401 Permit?		No	Issue Date: Expiration Date:
E. Tribal Water Quality Permit?		No	
F. CZM Consistency determination needed?			N/A
G. Erosion & Sediment Control Plan Required?		No	
H. Any other permits required?		No	Permit Information:
Other Information:			

Data Entered By: Bonnie Mcdonald

Date: Nov 27, 2024

FloodPlains & Wetlands Mitigations

No FloodPlains & Wetlands mitigations are associated with this project.

Wilderness

Question	Yes	No	
A. Does this project occur in or adjacent to Designated, Recommended, Proposed, Study, Eligible, or Potential Wilderness?		No	
B. Is the only place to conduct this project in wilderness?		No	
C. Is the project necessary for the administration of the area as wilderness?		No	
D. Would the project or any of its alternatives adversely affect (directly or indirectly) Designated, Recommended, Proposed, Study, Eligible, or Potential Wilderness? (If Yes, Minimum Requirements Analysis required)		No	
E. Does the project or any of its alternatives involve the use of any of the Wilderness Act Section 4(c) prohibited uses: commercial enterprise, permanent road, temporary road, motor vehicles, motorized equipment, motorboats, landing of aircraft, mechanical transport, structure, or installation? (If Yes, Minimum Requirements Analysis required)		No	
If the answer to D or E above is "Yes" then a Minimum Requirements Analysis is required. Describe the status of this analysis in the column to the right.			Initiation Date: Completed Date:

			Approved Date:
Other Information:			

Data Entered By: Bonnie Mcdonald **Date:** Nov 27, 2024

Other Permits/Laws *Questions A & B are no longer used.*

Question	Yes	No
C. Wild and scenic river concerns exist?		No
D. National Trails concerns exist?		No
E. Air Quality consult with State needed?		No
F. Consistent with Architectural Barriers, Rehabilitation, and Americans with Disabilities Acts or not Applicable? (If N/A check Yes)	Yes	
G. Other:		No

Other Information:

Data Entered By: Bonnie Mcdonald **Date:** Nov 27, 2024



Mitigations List Form

Date: Aug 5, 2025

Park: Yellowstone National Park

Project: Northeast Entrance Modular Housing (Replace Obsolete Trailers)

PEPC Project Number: 120137

Project Description:

Yellowstone National Park (YNP) is located in a remote area, with employees stationed and housed in developed areas throughout the park. The Northeast Entrance administrative area is approximately 49 miles from YNP headquarters in Mammoth Hot Springs, WY. YNP proposes to replace obsolete and previously removed 1970s mobile trailer units with two 2-bedroom modular housing units. The new units are needed in order to correct the health and safety, accessibility, environmental, deferred maintenance, and quality of life deficiencies within the parks housing accommodations.

This categorical exclusion revises the categorical exclusion (PEPC 102533) approved in May 2021 due to project changes and species recently listed under the protection of the Endangered Species Act.

The proposed project would occur in Park County, MT, within Yellowstone National Park, in a portion of the Northeast Entrance administrative area (44°0'18.65"N, 110°0'44.45"W). The 2-bedroom, 2-bathroom modular units would be 28-feet-wide by 40-feet-long with an 8-foot-deep covered porch (see attached photo and drawings). The modulares would be similar to those installed across the park in recent years; traditional design with timber accents, brown in color (see attached design). Work would include sewer, water, power telecoms and associated street improvements. All staging would be on hard surfaces (existing roads and parking areas) within the Northeast Entrance Administrative Area. The work would be done by independent contractors beginning in May 2026.

YNP Cultural Resources staff reviewed the proposed action. The area of potential effect is located within the Northeast Entrance Administrative Area north of the Northeast Entrance Road Historic District (48YE821) and the Northeast Entrance Station National Historic Landmark (48YE709). The proposed new modular housing units would not be visible from these nearby historic properties. Archaeological inventory efforts in 1983 identified no archaeological resources within the area of potential effect. In May 2021, MT SHPO concurred with NPS staff determination that the proposed action would have no adverse effect to any historic properties (see correspondence under PEPC 10253).

USFWS concurred with YNP's determination that the Project 'may affect but is not likely to adversely affect the Canada lynx, and the grizzly bear, is 'not likely to jeopardize the continued existence of the monarch butterfly and the Suckleys cuckoo bumble bee, would have 'no effect on the North American wolverine, the yellow-billed cuckoo, and the Ute ladies-tresses, and 'would not destroy or adversely modify designated Canada lynx critical habitat. The Services biological opinion states that the Project is not likely to jeopardize the continued existence of the whitebark pine with the incorporation of conservation measures. The anticipated level of whitebark pine removal caused by the proposed action would not appreciably reduce the overall population, reproduction, and distribution of whitebark pine throughout its range. See attachments within Other Compliance.

Project Locations:

Location

County:	Park	State:	MT
District:		Section:	

Geo. Marker:

Other:

Tract ID:

Funding

Source(s):

PMIS

Number(s):

Mitigation(s):

(the following is a complete list of all mitigations that will be incorporated into the above-referenced project)

- Soils, Topography, Geology - Erosion Controls : All erosion and sediment control devices shall be adequately maintained to assure continued performance of their intended function. Those that have sustained damage or have reached their capability shall be replaced or maintenance performed. (This General Conservation Measure was specified in USFWS Biological Opinion).
- Vegetation - Weed/Seed Free : All equipment and tools shall be cleaned completely prior to entering the work zone to prevent the spreading of non-invasive plant seeds. Equipment shall be inspected for compliance. (This General Conservation Measure was specified in USFWS Biological Opinion).
- Other : All material brought into the park from outside sources must be certified weed-free fill obtained from a recently certified facility. Please contact the Yellowstone Center for Resources (YCR) for the most up to date list of certified facilities in the GYE. (This General Conservation Measure was specified in USFWS Biological Opinion).
- Other : To minimize the amount of ground disturbance, staging and stockpiling areas would be located in previously disturbed sites if at all possible. All staging and stockpiling areas would be returned to pre-construction conditions following construction. Construction zones and staging areas would be identified and fenced with construction tape, snow fencing, or some similar material prior to any construction activity. The fencing would define the construction zone and confine activity to the minimum area required for construction. (This General Conservation Measure was specified in USFWS Biological Opinion).
- Other : Project shall comply with NPS and YNP lighting guidelines to reduce impacts to the night sky and wildlife. This will include, but is not limited to, low-level lighting, minimized glare, downward focused light fixtures, and energy efficient light sources such as low pressure sodium lamps. (This General Conservation Measure was specified in USFWS Biological Opinion).
- Rare, Threatened & Endangered Species : Ground disturbance from heavy equipment will be avoided within whitebark pine stands and within 10 meters (m; 33 feet) of known whitebark pine trees, which will protect the roots and soil within the drip line of large, mature trees. (This Whitebark Pine Conservation Measure was specified in USFWS Biological Opinion).
- Rare, Threatened & Endangered Species : If using heavy equipment in whitebark pine stands cannot be avoided, equipment will be used sparingly and will be cleaned before entering and leaving work sites to prevent the spread of invasive species, pathogens, and pests. (This Whitebark Pine Conservation Measure was specified in USFWS Biological Opinion).
- Rare, Threatened & Endangered Species : Pre-project surveys will be conducted to identify whitebark pine individuals of all age classes. (This Whitebark Pine Conservation Measure was specified in USFWS Biological Opinion).
- Rare, Threatened & Endangered Species : When marking is appropriate, clusters of whitebark pine trees will be marked (for avoidance) in a manner that does not cause damage to the tree or introduce disease. (This Whitebark Pine Conservation Measure was specified in USFWS Biological Opinion).
- Rare, Threatened & Endangered Species : Off road motorized travel in whitebark pine habitat will be avoided. (This Whitebark Pine Conservation Measure was specified in USFWS Biological Opinion).
- Rare, Threatened & Endangered Species : When working in whitebark pine stands, work will not introduce or spread Ribes species that are an alternate host for white pine blister rust. (This Whitebark Pine Conservation Measure was specified in USFWS Biological Opinion).
- Rare, Threatened & Endangered Species : Herbicide spot treatments for infrastructure activities will maintain a minimum distance of 1 m (3.3 feet) from a whitebark pine tree. Ground-based broadcast applications will maintain a minimum distance of 3 m (10 feet) from the trunk of a whitebark pine tree. (This Whitebark Pine Conservation Measure was specified in USFWS Biological Opinion).

- Rare, Threatened & Endangered Species : Train project personnel to identify the species regardless of their age class (seedling, sapling, and mature trees) to ensure project activities do not result in more adverse effects than described in the project description. (This Whitebark Pine Conservation Measure was specified in USFWS Biological Opinion).
- Rare, Threatened & Endangered Species : Wherever possible, avoid removing or damaging healthy, unsuppressed whitebark trees. Limit soil disturbance and compaction by limiting the use of mechanical equipment such as heavy equipment and vehicles. Control runoff of soil during project activities and avoid using machinery in wet soils and areas prone to ruts. (This Whitebark Pine Conservation Measure was specified in USFWS Biological Opinion).
- Wildlife : To avoid impacts to migratory birds during nesting season, please consider conducting all vegetation removal activities outside of March 1 - August 15th for raptors, and May 1 - August 15th for songbirds. If you are within the March 1 - August 15 window, and you suspect active nests from detection of physical structures (e.g. large collections of sticks or smaller plant material in nest-like shape, cavity holes) or behaviors (e.g. birds in and out of tree cavities, activity at nest-like structures in trees, birds carrying food into nest-like structures), please contact the Bird Program Manager at 307-344-2218 or david_b_haines@nps.gov to discuss or schedule a survey.
- Assessment of Effect - Museum Collections & Archives : Any and all historic objects discovered during this project (i.e. under foundations, in wall, attic, or crawl spaces, etc.) remain property of the federal government and shall be considered by the YELL Collections Committee for accessioning into the park unit's museum collection whether they are stored at an NPS facility or placed on loan to an agreed upon repository.
- Human Health & Safety : Line locates must be completed before any excavation work may begin. The depth of utility line varies and there may be multiple utility lines in a common area. Digging without calling can disrupt service, harm you and those around you and potentially result in fines and repair costs. Calling 811 before every job gets underground utility lines marked for free and helps prevent undesired consequences.
- Night Sky : Project shall comply with NPS and park lighting guidelines to reduce impacts to the night sky and wildlife. This will include, but is not limited to, low-level lighting, minimized glare, downward focused light fixtures, and energy efficient light sources such as low-pressure sodium lamps.
- Other : Please contact your compliance representative if the scope of work changes to ensure proper compliance documentation has been completed. Upon project completion, please send a written summary, with photos if possible, to close out the administrative record for your project.
- Other : All material brought into the park from outside sources must be certified weed-free fill obtained from a recently certified facility. Please contact The Yellowstone Center for Resources for the most up to date list of certified facilities in the GYE.
- Other : To minimize the amount of ground disturbance, staging and stockpiling areas would be located in previously disturbed sites if at all possible. All staging and stockpiling areas would be returned to pre-construction conditions following construction. Construction zones and staging areas would be identified and fenced with construction tape, snow fencing, or some similar material prior to any construction activity. The fencing would define the construction zone and confine activity to the minimum area required for construction.
- Park Operations & Mgmt - Construction General : Contractors would coordinate with park staff to reduce disruption in normal park activities (i.e. facilitate emergency traffic, and hauling material, to allow for visitor use in areas where no conflicts or safety concerns exist)
- Park Operations & Mgmt - Construction General : Project manager will ensure residents are properly notified of project related activities including closures, detours, power outages, and invasive plant treatment as necessary, prior to commencement of the aforementioned activities.
- Park Operations & Mgmt - Construction General : To the extent practical, work shall be scheduled to avoid construction activity and construction related delays during peak visitation times. No holiday or night time work shall be allowed. Weekend work (Friday through Sunday) shall not be allowed unless authorized in writing by the park's Superintendent.
- Rare, Threatened & Endangered Species : The project lead will ensure that all project-related employees, such as contract employees, would be given orientation on how to avoid disturbing or encountering bears and how to minimize unavoidable effects or encounters. Orientation would include information about park regulations regarding food storage, disposal of garbage and other bear attractants, and approaching or harassing wildlife.
- Rare, Threatened & Endangered Species : Ensure work crews adhere to bear safety and food storage regulations.
- Assessment of Effect - Archaeology : If previously unknown archeological or paleontological resources are discovered during construction activities, all ground disturbing activities in the immediate vicinity (300 feet) of the discovery shall be halted and the Park Archaeologist notified immediately. Cultural resources will be identified and

documented by an archaeologist meeting the NPS Qualification Standards and the Secretary of the Interior's Professional Qualification Standards. An appropriate mitigation strategy will be developed, if necessary, in accordance with pertinent laws and regulations.

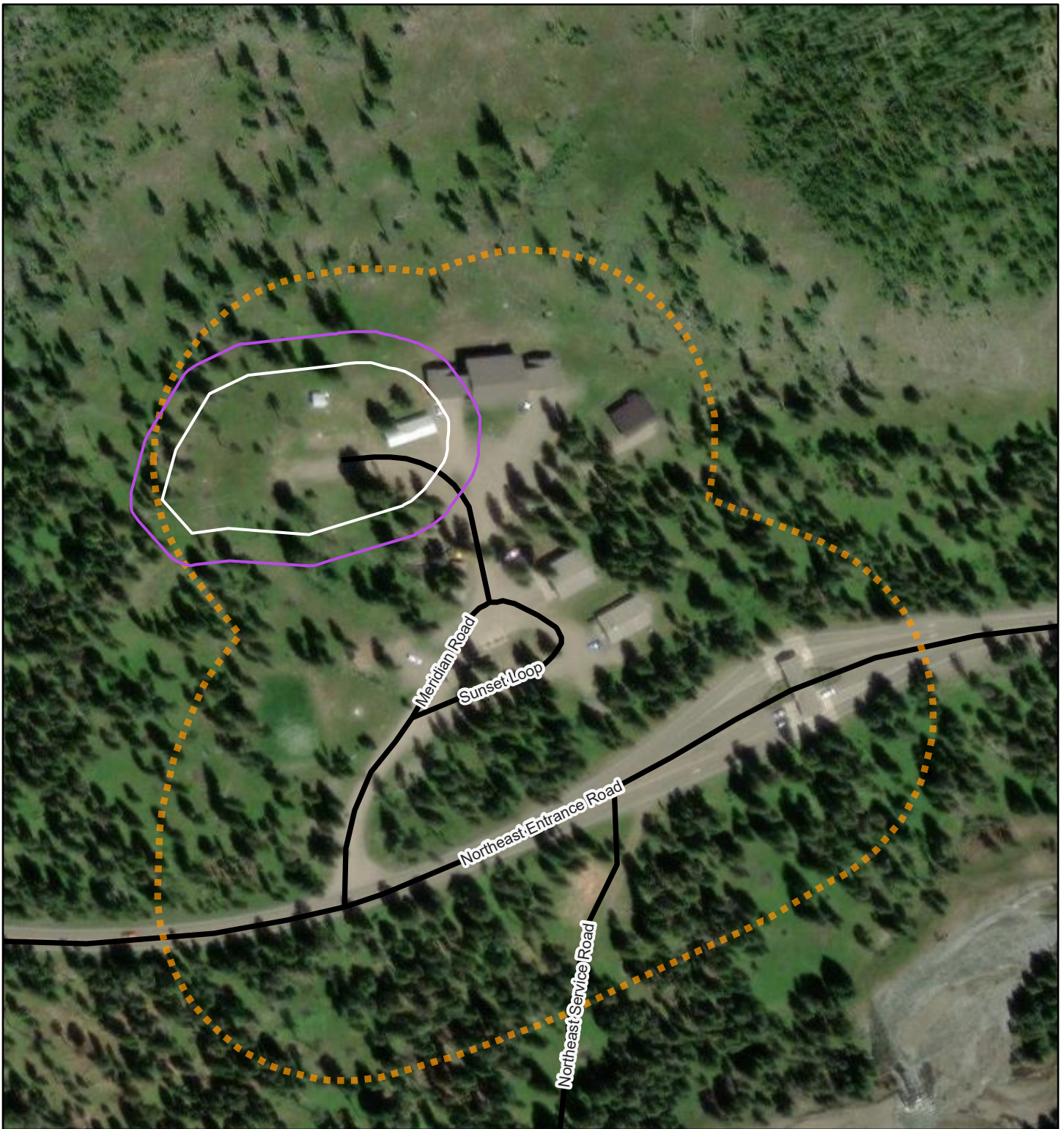
- Assessment of Effect - NAGPRA : In the event that human remains are discovered during fuels reduction activities, all activities in the vicinity of the discovery must stop and the Park Archeologist, Branch Chief of Cultural Resources, NPS Supervisory LE Ranger for Grant contacted immediately. If the remains are determined to have no forensic value and are of Native American or Native Hawaiian descent or an historical person, all provisions outlined in the Native American Graves Protection and Repatriation Act (1990), as amended, will be followed.

Comment:

Recommendations for Conditions or Stipulations:

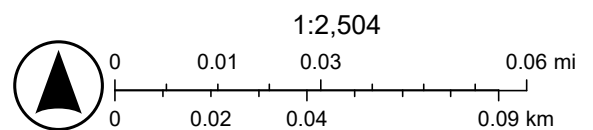
None

YELL Resource Viewer Map



12/16/2024, 1:53:18 PM

- AOI - Housing
-  Whitebark Pine 33ft Buffers
-  Grizzly Bear Conservation Strategy Areas
-  Roads



Maxar, Microsoft, NPS

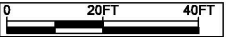
10/31/2024 8:31 AM C:\p_w\working\intra03\borner\40160248\185706708_NEentrance_conceptlayout_10-28-2024.dwg



LEGEND

- STANDARD UNIT
- ACCESSIBLE UNIT
- ASPHALT DRIVEWAY
- TEMPORARY RV PAD FOR FUTURE RV PARKING
- SIDEWALK
- EXISTING ROADWAY
- EXISTING WATER UTILITIES
- EXISTING WASTEWATER UTILITIES
- EXISTING ELECTRICAL UTILITIES
- PROPOSED WATER UTILITIES (DEPICTION)
- PROPOSED WASTEWATER UTILITIES (DEPICTION)
- PROPOSED ELECTRICAL UTILITIES (DEPICTION)
- PROPOSED CULVERT
- EXISTING MAJOR CONTOURS
- EXISTING MINOR CONTOURS
- 5-NEEDLE PINE
- TREE
- WETLAND AREA LIMITS

ITEM	QUANTITY
MODULAR UNITS	2
PARKING SPACES	6
NEW ASPHALT PAVING (SF)	5,039
APPROX WETLAND IMPACT AREA (AC)	N/A



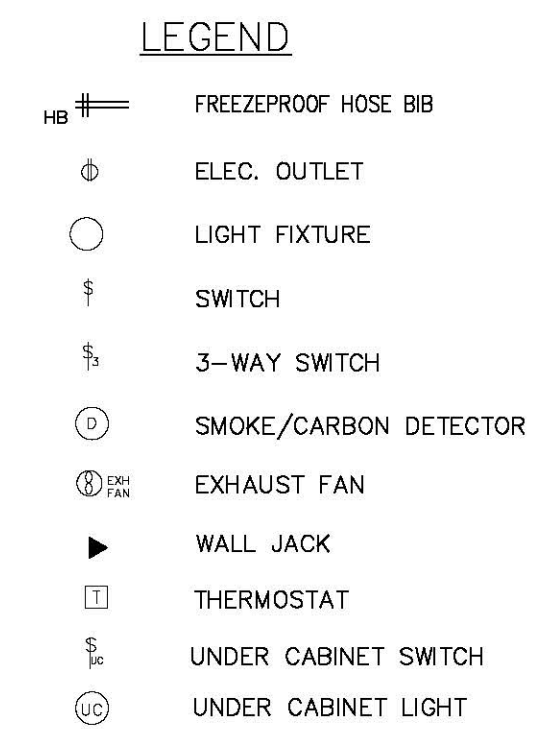
DESIGNED:
STANTEC
BB
TECH. REVIEW:
DATE:
11/7/24

SUB SHEET NO.
C3.3

TITLE OF SHEET
NE ENTRANCE
PRELIMINARY PLAN
NE ENTRANCE MODULAR UNITS
YELLOWSTONE NATIONAL PARK

DRAWING NO.
YELL
101/192110
PMIS/PKG NO.
326141A/326104
SHEET
4 OF 8





1. ALL DIMENSIONS ON THIS PLAN ARE TO THE FACE OF STUD OR POST UNLESS NOTED OTHERWISE.
2. ALL EXTERIOR WALLS ARE 2x6 AT 16"o/c AT RESIDENCE AND 2x6 AT 16"o/c AT GARAGE. ALL INTERIOR WALLS ARE 2x4 AT 16"o/c UNLESS NOTED OTHERWISE.
3. SEE SHEET #2 FOR ADDITIONAL NOTES AND ROOM FINISH, DOOR AND WINDOW SCHEDULES.

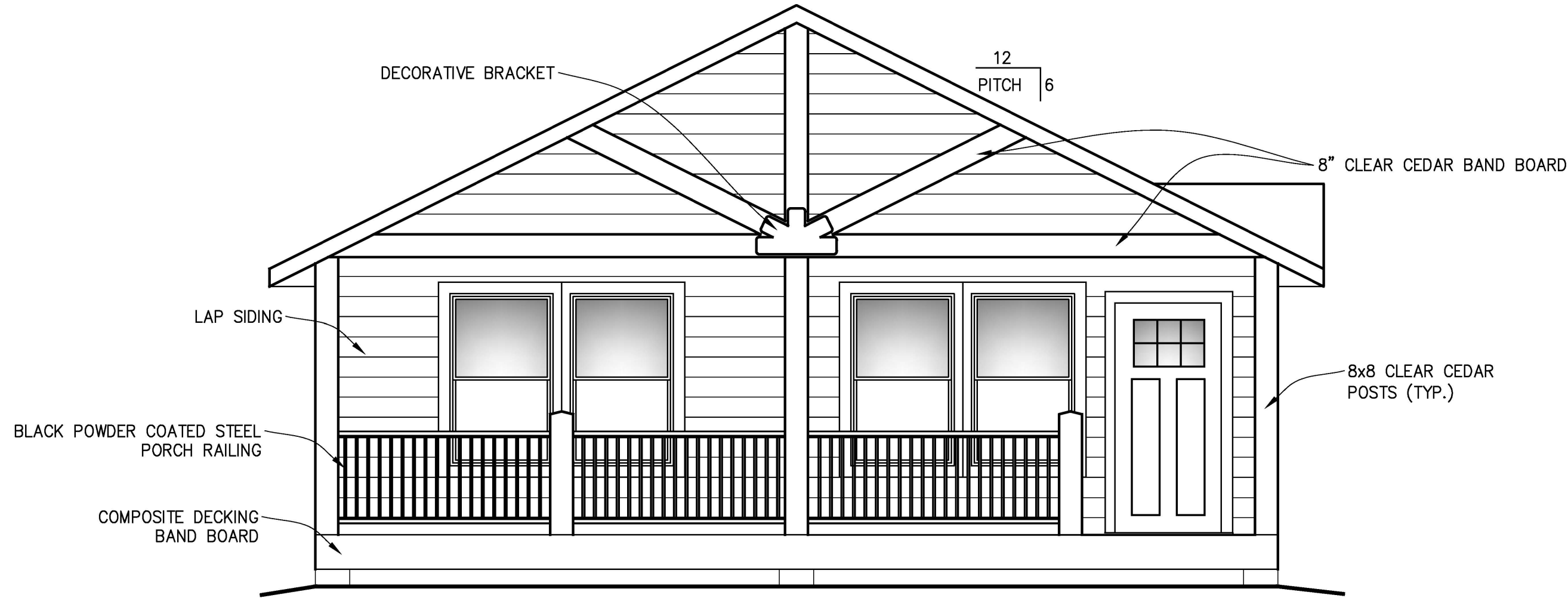
<u>FOOTAGE</u>	
LIVABLE SPACE	1060 SF
PORCH	224 SF

EMPLOYEE HOUSING
TWO BEDROOM AND
2 BATHROOM MODULAR

SHEET NUMBER

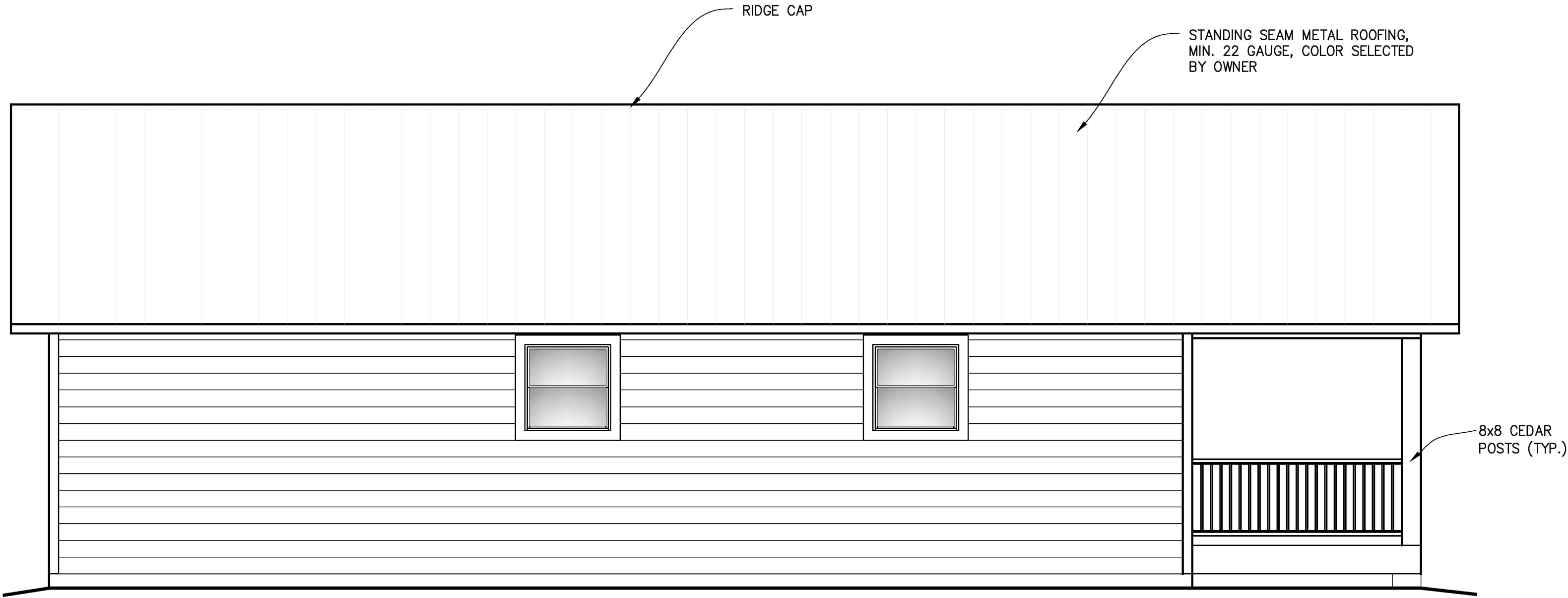
3

7 SHEETS



FRONT ELEVATION

SCALE: 1/4" = 1'-0"



LEFT SIDE ELEVATION

SCALE: 3/16" = 1'-0"

VERIFY SCALE!
IF PRINTED AT A SIZE OTHER THAN 11" X 17"
REDUCE OR ENLARGE DRAWING
MEASURES ONE INCH ON
ORIGINAL DRAWING.

NO. DESCRIPTION DATE BY

REVISIONS

MODIFY SCALE
ACCORDINGLY!

DRAWN BY: KS
CHK'D BY:
APPR. BY:
DATE: 1/2024

YELLOWSTONE NATIONAL PARK
22 STABLE STREET
YNP, WY 82190

EMPLOYEE HOUSING
TWO BEDROOM AND
2 BATHROOM MODULAR

SHEET NUMBER
4
OF 7 SHEETS

APPENDIX B

USFWS Programmatic Biological Opinion



United States Department of the Interior

FISH AND WILDLIFE SERVICE
334 Parsley Blvd.
Cheyenne, Wyoming 82007



In Reply Refer to:
FWS/R6/2025-0084389

Memorandum

To: Superintendent, Yellowstone National Park, National Park Service, Mammoth, Wyoming

JENNIFER HILL Digitally signed by JENNIFER HILL
Date: 2025.05.23 14:57:35 -06'00', Acting

From: Field Supervisor, Wyoming Ecological Services Field Office, U.S. Fish and Wildlife Service, Cheyenne, Wyoming

Subject: Programmatic Biological Opinion for the Effects to Whitebark Pine from the Parkwide Housing Projects in Yellowstone National Park, Park and Gallatin Counties, Montana, and Park and Teton Counties, Wyoming

This document transmits the programmatic biological opinion of the U.S. Fish and Wildlife Service (Service) based on our review of the effects on whitebark pine (*Pinus albicaulis*) from the National Park Service's (NPS) proposed Parkwide Housing Projects (Project) in Yellowstone National Park (YNP), in Park and Teton Counties, Wyoming, and Park and Gallatin Counties, Montana. This review is pursuant to section 7(a)(2) of the Endangered Species Act of 1973, as amended (ESA; 16 U.S.C. 1531 *et seq.*). The request for formal consultation was received on April 30, 2025, with the biological assessment (BA) and supplemental information and supporting files.

The YNP determined that the Project 'may affect but is not likely to adversely affect' the Canada lynx, (*Lynx canadensis*) and the grizzly bear (*Ursus arctos*), is 'not likely to jeopardize the continued existence' of the monarch butterfly (*Danaus plexippus*) and the Suckley's cuckoo bumble bee (*Bombus suckleyi*), will have 'no effect' on the North American wolverine (*Gulo gulo luscus*), the yellow-billed cuckoo (*Coccyzus americanus*), and the Ute ladies'-tresses (*Spiranthes diluvialis*), and 'will not destroy or adversely modify' designated Canada lynx critical habitat. We concur with the 'may affect, not likely to adversely affect' determinations for the Canada lynx and the grizzly bear, the determination that the Project 'will not jeopardize the continued existence' of the monarch butterfly or the Suckley's cuckoo bumble bee, and the determination that the Project 'will not destroy or adversely modify' designated Canada lynx critical habitat. Our concurrence is based on our understanding of the proposed Project, which includes information provided in your BA. While the Service does not provide concurrence on 'no effect' determinations, we appreciate having this information for our records. This

concludes informal consultation for the above-mentioned species and critical habitat for the proposed Project.

This programmatic biological opinion is based on information provided in the 2025 BA, field investigations, peer-reviewed scientific literature, and the best available scientific data. Literature cited in this programmatic biological opinion is not a complete bibliography of all literature available on the species of concern, or of infrastructure maintenance activities and their effects, or on other subjects considered in this opinion. A complete decision file of this consultation is available at Wyoming Ecological Services Field Office.

We appreciate your efforts to ensure the conservation of endangered, threatened, proposed and candidate species. If you have questions regarding this letter or your responsibilities under the ESA, please contact Heather O'Brien of my office at heather_obrien@fws.gov or by phone at (307) 996-8486.

Attachment: Programmatic Biological Opinion for the Effects to Whitebark Pine from the Parkwide Housing Project in Yellowstone National Park, Park and Gallatin Counties, Montana, and Park and Teton Counties, Wyoming

cc: National Park Service, Superintendent, Yellowstone National Park, Mammoth, WY (C. Sholly) (cam_sholly@nps.gov)
National Park Service, Environmental Protection Specialist, Yellowstone National Park, Mammoth, WY (C. Gabriel) (christine_gabriel@nps.gov)
Wyoming Game and Fish Department, Statewide Habitat Protection Program, Cheyenne, WY (wgfd.hpp@wyo.gov)

PROGRAMMATIC BIOLOGICAL OPINION

for the

Effects to Whitebark Pine from the Parkwide Housing Project in Yellowstone National Park,
Park and Gallatin Counties, Montana and Park and Teton Counties, Wyoming

U.S. Fish and Wildlife Service Reference Number 2025-0084389

Prepared by: U.S. Fish and Wildlife Service
Wyoming Ecological Services Field Office
May 23, 2025

Issued by: JENNIFER HILL Digitally signed by JENNIFER HILL
Date: 2025.05.23 14:59:27 -06'00', *Acting*

Tyler A. Abbott, Field Supervisor

PROGRAMMATIC BIOLOGICAL OPINION

1. INTRODUCTION

The U.S. Fish and Wildlife Service (Service) has completed this programmatic biological opinion (PBO) in response to our review of the effects on whitebark pine (*Pinus albicaulis*) from the National Park Service's (NPS) proposed Parkwide Housing Project (Project), pursuant to section 7(a)(2) of the Endangered Species Act of 1973, as amended (ESA; 16 U.S.C. 1531 *et seq.*). The NPS determined that this Project 'may affect and is likely to adversely affect' whitebark pine. The Project programmatically addresses impacts relating to the installation of new modular housing units, detached garages, a new 2-story dormitory, and a new fitness center located across eight developed sites in Yellowstone National Park (YNP). The request for formal consultation was received on April 30, 2025. The initial biological assessment and supplemental information serve as the Project's biological assessment (BA).

Regulations direct the Service to evaluate whether a proposed action is likely to jeopardize the continued existence of threatened or endangered species. This PBO is based on information regarding direct, indirect, and cumulative effects (together, "consequences") of the action; conditions forming the environmental baseline; and the species' ecological status. Based on the analysis presented in the BA, it is the Service's biological opinion that the effects associated with the proposed action are likely to adversely affect but are not likely to jeopardize the continued existence of the whitebark pine. No critical habitat has been designated for this species.

2. DESCRIPTION OF THE PROPOSED ACTION

Regulations implementing the ESA (50 CFR § 402.02) define "action" as "all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by federal agencies of the United States or upon the high seas." The following is a description of the proposed action. Additional information can be found in the Project BA incorporated here by reference (NPS 2025).

The proposed Project involves new construction and/or replacement of obsolete trailer homes with 50 new, 2-bedroom and 2-bath modular housing units, construction of detached garages, replacement of an old dormitory with a larger, 2-story dormitory, and construction of an employee fitness center. Project goals are to improve health, safety, and accessibility for employees; to improve environmental quality, maintenance efficiency, and quality of housing; and to utilize construction designs to better withstand snow and weather conditions within YNP. The Project programmatically addresses the similar construction activities at ten housing sites located within eight separate developed areas in Park and Gallatin Counties, Montana, and Park and Teton Counties, Wyoming, within YNP (Figure 1). Activities at all ten sites are bundled and addressed together in this Project, as they consist of similar upgrades and replacement activities and are located within comparable developed areas. The action area for the Project encompasses the sum of all site activities and totals approximately 87.08 acres (Table 1). Construction is proposed to begin in summer of 2025 and are expected to continue through summer of 2028 to complete construction and upgrades at all sites included in the Project.



Figure 1. Parkwide housing project general locations (orange) in Yellowstone National Park.

Housing Area	# of New Houses	Acreage Impact (acres)	Proposed Start (projected)	Proposed Completion (projected)
Canyon Junction - Boneyard	Ten 2-bedroom units (no garages)	14.39	May 2026	May 2027
Canyon Junction - Neighborhood Circle	Nine 2-bedroom units with detached garage for each unit	17.08	May 2027	May 2028
Canyon Junction - Delaware North Dorm	49 double rooms and 5 single rooms	5.14	Fall 2025	Summer 2027
Grant Village - Site #3	Eight 2-bedroom units with detached garage for each unit	15.18	May 2027	May 2028
Madison Junction	Three 2-bedroom units with detached garage for each unit	6.11	June 2026	October 2026
Norris Junction	Two 2-bedroom units with detached garage for each unit	3.04	June 2026	August 2026
Northeast Entrance	Two 2-bedroom units (no garages)	1.64	May 2026	May 2027
Old Faithful	Four 2-bedroom units and 1 fitness center unit	4.31	ASAP - Fitness Center August 2027 - Modular Units	September 2027
South Entrance	Six 2-bedroom units with detached garage for each unit	6.48	June 2026	June 2027
West Entrance	Six 2-bedroom units with detached garage for each unit	13.72	September 2026	September 2027
	Total Acres	87.08		

Table 1. Summary of Programmatic Parkwide Housing Project sites, acreage impacted, and proposed construction timelines.

Along with installation of the 50 modular housing structures, work at each site will include sewer, water, power, and telecom connections and associated street improvements. Project sites were selected in developed areas to maximize use of previous disturbance and to facilitate connections to utility lines and existing roads. New modular homes to be installed are 1,344 square feet (ft²) in size and would require excavation 5 feet in depth for foundation construction, plus trenching for hookups to existing utilities up to 6 feet in depth. Between two and ten modular homes will be installed at each Project site, with some including garage units and others including paved parking. In addition to modular housing, a new 2-story dormitory will be constructed at the Canyon Junction developed area. The adjacent existing dormitory will be torn down, and its footprint will be converted to parking for the new dormitory. Finally, a fitness

facility will be constructed in an area where obsolete housing trailers will be removed at the Old Faithful developed site.

Equipment used for project activities includes mini and full-size excavators, cranes, skid steers, bulldozers, dump and water trucks, temporary fuel tanks, boom trucks, compactors, pipefitting and welding equipment, cutting and grinding equipment, concrete and paving equipment, and generators. Multiple crews may be active at any time at different sites for the Project. Vegetation will be removed within the construction disturbance limits of each site within the Project. Efforts will be made to save and replace vegetation within the Project area if construction activities allow. Where needed, reseeding and weed control would be implemented after Project completion. All construction and equipment staging will be on hard surfaces (existing roads and parking areas). Project work at all sites will avoid impacts to wetlands to the extent possible. Additional information on each aspect of the Project, including detailed maps, can be found in the BA and supplemental information.

Conservation Measures

The NPS and YNP will implement the following conservation measures with the intent to avoid and minimize adverse effects resulting from the Project:

Whitebark Pine Conservation Measures

- Pre-project surveys will be conducted to identify whitebark pine individuals of all age classes.
- When marking is appropriate, clusters of whitebark pine trees will be marked (for avoidance) in a manner that does not cause damage to the tree or introduce disease.
- Ground disturbance from heavy equipment will be avoided within whitebark pine stands and within 10 meters (m; 33 feet) of known whitebark pine trees, which will protect the roots and soil within the drip line of large, mature trees.
- If using heavy equipment in whitebark pine stands cannot be avoided, equipment will be used sparingly and will be cleaned before entering and leaving work sites to prevent the spread of invasive species, pathogens, and pests.
- Off road motorized travel in whitebark pine habitat will be avoided.
- When working in whitebark pine stands, work will not introduce or spread *Ribes* species that are an alternate host for white pine blister rust.
- Herbicide spot treatments for infrastructure activities will maintain a minimum distance of 1 m (3.3 feet) from a whitebark pine tree. Ground-based broadcast applications will maintain a minimum distance of 3 m (10 feet) from the trunk of a whitebark pine tree.
- Train project personnel to identify the species regardless of their age class (seedling, sapling, and mature trees) to ensure project activities do not result in more adverse effects than described in the project description.

- Wherever possible, avoid removing or damaging healthy, unsuppressed whitebark trees. Limit soil disturbance and compaction by limiting the use of mechanical equipment such as heavy equipment and vehicles. Control runoff of soil during project activities and avoid using machinery in wet soils and areas prone to ruts.
- Minimize creation of dust when using mechanical equipment (heavy equipment and vehicles).

General Conservation Measures

- To minimize the amount of ground disturbance, staging and stockpiling areas would be located in previously disturbed sites, if at all possible. All staging and stockpiling areas will be returned to pre-construction conditions following construction. Construction zones and staging areas will be identified and fenced with construction tape, snow fencing, or similar material prior to any construction activity. Fencing will define the construction zone and confine activity to the minimum area required for construction.
- All material brought into the YNP from outside sources must be certified weed-free fill obtained from a recently certified facility. Please contact the Yellowstone Center for Resources for the most up to date list of certified facilities in the Greater Yellowstone Ecosystem (GYE).
- All equipment and tools shall be cleaned completely prior to entering the work zone to prevent the spreading of non-invasive plant seeds. Equipment shall be inspected for compliance.
- All wetlands within or adjacent to Project areas must be avoided. Wetlands to be avoided will be marked on the maps/plans provided to construction contractor and flagged prior to start of work.
- Project shall comply with NPS and YNP lighting guidelines to reduce impacts to the night sky and wildlife. This will include, but is not limited to, low-level lighting, minimized glare, downward focused light fixtures, and energy efficient light sources such as low-pressure sodium lamps.
- All erosion and sediment control devices shall be adequately maintained to assure continued performance of their intended function. Those that have sustained damage or have reached their capability shall be replaced or maintenance performed.
- To avoid impacts to migratory birds during nesting season, tree removal activities would only occur outside of the nesting window, March 1 - August 15 for raptors, and May 1 - August 15 for songbirds. If active nests are suspected because of observed structures or behaviors (e.g. large collections of sticks or smaller plant material in nest-like shape, cavity holes; birds in and out of tree cavities, activity at nest-like structures in trees, birds carrying food into nest-like structures), the Yellowstone Bird Program Manager should be contacted to discuss a survey prior to any tree removal activities.

Analytical Framework for Jeopardy

In accordance with regulation (84 FR 50333 [September 25, 2019]), the jeopardy determination in this PBO relies on the following four components:

1. The *Status of the Species*, which evaluates the species' current range-wide condition relative to its reproduction, numbers, and distribution; the factors responsible for that condition; its survival and recovery needs; and explains if the species' current range-wide population is likely to persist while retaining the potential for recovery or is not viable;
2. The *Environmental Baseline*, which evaluates the current condition of the species in the action area relative to its reproduction, numbers, and distribution absent the consequences of the proposed action; the factors responsible for that condition; and the relationship of the action area to the survival and recovery of the species;
3. The *Effects of the Action*, which evaluates all future consequences to the species that are reasonably certain to be caused by the proposed action, including the consequences of other activities that are caused by the proposed action but are not part of the action, and how those impacts are likely to influence the survival and recovery role of the action area for the species; and,
4. *Cumulative Effects*, which evaluates the consequences of future, non-federal activities reasonably certain to occur in the action area on the species, and how those impacts are likely to influence the survival and recovery role of the action area for the species.

In accordance with policy and regulation, the jeopardy determination is made by evaluating the consequences of the proposed federal action in the context of the species' current range-wide status, taking into account any cumulative effects, to determine if implementation of the proposed action is likely to cause an appreciable reduction in the likelihood of both the survival and recovery of the species in the wild. The key to making this finding is clearly establishing the role of the action area in the conservation of the species as a whole, and how the effects of the proposed action, taken together with cumulative effects, are likely to alter that role and the continued existence (*i.e.*, survival) of the species.

3. STATUS OF THE SPECIES

The Service provided a thorough status assessment of the species in the 2021 Species Status Assessment (SSA; Service 2021) which is incorporated by reference, with a summary provided below.

Regulatory Status

On December 15, 2022, the Service published the final rule to list the whitebark pine as a threatened species (87 FR 76882) under the ESA. Concurrently the Service also published a final 4(d) rule for the whitebark pine that identified actions necessary for the conservation and recovery of the species. Prohibited acts and a limited number of exceptions were included in the same federal register publication. No critical habitat was proposed for whitebark pine. Section 4(d) rules cannot, and do not, absolve federal agencies of their consultation requirements under section 7 of the ESA.

Species Description and Taxonomy

The whitebark pine is a five-needle conifer species in the subgenus *Strobos*, which includes other five-needle white pines. Recent phylogenetic studies (Liston *et al.* 1999; Syring *et al.* 2005, 2007) as cited in Committee on the Status of Endangered Wildlife in Canada (COSEWIC 2010) showed no difference in monophyly (ancestry) between subsection *Cembrae* and subsection *Strobi* and merged them to form subsection *Strobos*. No taxonomic subspecies or varieties of whitebark pine are recognized (COSEWIC 2010). Based on this taxonomic classification information, we recognize whitebark pine as a valid species (Service 2021).

Distribution and Status

Estimates of whitebark pine population size are based on coarse-scale modeling approaches. Goeking and Izlar (2018) completed assessments of population size, extrapolating from Forest Inventory and Analysis plot data (<https://research.fs.usda.gov/programs/fia>) and is considered one of the more accurate models. Their assessment estimated whitebark pine occurred on 10.2 million acres in the U.S. (Goeking and Izlar 2018). Whitebark pine density and occupancy vary greatly throughout windy, cold, high elevation or high latitude environments. Roughly 70 percent of the species' range occurs in the United States, with the remaining 30 percent of its range in Canada (Service 2018). In the U.S., approximately 99 percent of land where the species is distributed is federally owned or managed, with the majority located on USFS lands (approximately 74 percent; Service 2023).

Life History and Population Dynamics

There are four stages in the life cycle of the whitebark pine: seed, seedling, sapling, and mature tree, also referred to as reproductive adults. Mature reproductive white bark pine produce both female and male cones and can survive on the landscape for hundreds of years. Seeds are produced in pollinated female cones, which require two summers of suitable temperatures and precipitation to mature (Service 2021). Once on the ground, seeds may take two years or more (up to 11 years in some cases) to germinate. Germinated seeds become seedlings that are between 3 to 4 inches tall (8 and 10 centimeters) with a taproot that can measure between 5 and 7 inches (13 to 18 centimeters; Arno and Hoff 1989). Whitebark pine may persist for multiple years in both seedlings and sapling life stages depending on growing conditions and are classified as mature once they begin to produce male and female cones. This slow-growing long-lived tree can have a life span between 500 years and 1,000 years (Arno and Hoff 1989; Perkins and Swetnam 1996). Whitebark pine thrive in areas with lower interspecific competition such as habitats with a more open canopy, low litter depth, and high rock cover (Maloney *et al.* 2012).

Populations are typically defined by the potential for genetic exchange among members, to the exclusion of members of other populations (in the absence of immigration or emigration). For whitebark pine, genetic exchange is limited by the dispersal distance of wind-carried pollen, and the seed-caching behavior of Clark's nutcracker (*Nucifraga columbiana*; Keane *et al.* 2017; Lorenz *et al.* 2011). Both pollen and seed dispersal can occur at a scale of few to many kilometers (km) (*e.g.*, up to 30 km in the case of Clark's nutcracker seed dispersal; Lorenz *et al.* 2011). To promote a greater than 75 percent probability of occurrence of Clark's nutcracker at a site, management plans are recommended that achieve landscape composition of a minimum 12,500-25,000 hectares (30,888- 61,776 acres) of cone-bearing whitebark pine habitat within a

32.6-km radius. Optimal Clark's nutcracker habitat includes a mosaic with moderate levels of Douglas-fir (*Pseudotsuga menziesii*), as their seeds are another important food source (Schaming 2016; Schaming and Sutherland 2020).

Whitebark pine exhibits masting, where years of high seed production are synchronized within a population every 3 to 5 years (McCaughey and Tomback 2001). Masting is an adaptation strategy to counter heavy seed predation; during masting years consumers are satiated, resulting in excess seeds that escape predation (Lorenz *et al.* 2008). Whitebark pine populations need a certain density of reproductive individuals and adequate nutrients to produce sufficient pollen clouds to support masting. Years with high pollen production facilitate the synchronization of masting, and thus increase the probability of regeneration (Rapp *et al.* 2013). Ultimately, in addition to the general needs for all life stages, mature whitebark pine trees require a more open canopy, two summers of suitable temperatures and precipitation for pollinated cones to mature, dispersal of seeds by Clark's nutcracker, and levels of nitrogen and phosphorus that are adequate to restore values after being depleted in masting years (Service 2021).

Habitat

Whitebark pine typically occurs on cold and windy high-elevation or high-latitude sites in western North America, although it also occurs in scattered areas of the warm and dry Great Basin. As a result, many stands are geographically isolated (Arno and Hoff 1989; Keane and Parsons 2010). The distribution of whitebark pine includes coastal and Rocky Mountain ranges that are connected by scattered populations in northeastern Washington and southeastern British Columbia (Arno and Hoff 1989; Keane and Parsons 2010). The coastal distribution of whitebark pine extends from the Bulkley Mountains in northwestern British Columbia to the northeastern Olympic Mountains and Cascade Range of Washington and Oregon, to the Kern River of the Sierra Nevada Range of east-central California (Arno and Hoff 1989). Isolated stands of whitebark pine are known from the Blue and Wallowa Mountains in northeastern Oregon and the subalpine zone of mountains in northeastern California, south-central Oregon, and northern Nevada (Arno and Hoff 1989; Keane and Parsons 2010). The Rocky Mountain distribution of whitebark pine ranges from northern British Columbia and Alberta to Idaho, Montana, Wyoming, and Nevada (Arno and Hoff 1989; Keane and Parsons 2010), with extensive stands occurring in the Yellowstone ecosystem (McCaughey and Schmidt 2001).

In general, the upper elevational limits of whitebark pine decrease with increasing latitude throughout its range (McCaughey and Schmidt 2001). The elevational limit of the species ranges from approximately 900 m (2,950 feet) at its northern limit in British Columbia to 3,660 m (12,000 feet) in the Sierra Nevada (McCaughey and Schmidt 2001). Whitebark pine is typically found growing at the subalpine tree line or with other high-mountain conifers just below the tree line and subalpine zone (Arno and Hoff 1989; McCaughey and Schmidt 2001). In the Rocky Mountains, common associated tree species include lodgepole pine (*Pinus contorta* var. *latifolia*), Engelmann Spruce (*Picea engelmannii*), subalpine fir (*Abies lasiocarpa*), and mountain hemlock (*Tsuga mertensiana*). Common associated tree species are similar in the Sierra Nevada and Blue and Cascade Mountains, except lodgepole pine is present as Sierra-Cascade lodgepole pine (*P. contorta* var. *murrayana*) and mountain hemlock is absent from the Blue Mountains (Arno and Hoff 1989; McCaughey and Schmidt 2001).

Threats to the Species

Major threats to whitebark pine include mortality from disease caused by the non-native white pine blister rust, and predation by the native mountain pine beetle (*Dendroctonus ponderosae*). White pine blister rust is a disease of five-needle pines (*Pinus* spp.) caused by a nonnative fungus, *Cronartium ribicola* (Geils *et al.* 2010). While white pine blister rust occurs throughout the entire whitebark pine range, not all trees are infected, and infection rates vary widely. Location of the blister rust infection in whitebark pine can indicate severity where canopy infections (branches) are less severe than bole (trunk) infections, though both the canopy and trunk can be infected simultaneously (Shanahan *et al.* 2025). The white pine blister rust fungus has a complex life cycle. It does not spread directly from one tree to another, but alternates between primary hosts (*i.e.*, five-needle pines) and alternate hosts. Alternate hosts in western North America are typically woody shrubs in the genus *Ribes* (gooseberries and currants) but also may include herbaceous species of the genus *Pedicularis* (lousewort) and the genus *Castilleja* (paintbrush; McDonald *et al.* 2006; McDonald and Hoff 2001). ‘Plus’ trees, which are individual trees suspected to have phylogenetic resistance to white pine blister rust, and ‘elite’ trees, which are known to have phylogenetic resistance, have observable resistant characteristics resulting from the interaction of its genotype with the environment. ‘Plus’ and ‘elite’ tree identification, protection, and propagation are important for whitebark pine recovery.

The mountain pine beetle is recognized as one of the principal sources of whitebark pine mortality (Arno and Hoff 1989; Raffa and Berryman 1987). Mountain pine beetles feed on whitebark pine and other western conifers and must kill host trees to successfully reproduce (Logan and Powell 2001; Logan *et al.* 2010). Upon locating a suitable host (*i.e.*, large diameter tree with sufficient resources for brood production success), adult female mountain pine beetles emit pheromones that attract adult males and other adult females to the host tree. This initiates a synchronized mass attack for the purpose of overcoming the host tree's defenses to mountain pine beetle predation. Once a tree has been fully colonized, the beetles produce an anti-aggregation pheromone that signals to incoming beetles to pass on to nearby unoccupied trees. Almost all host trees, even stressed individuals, will mount a physiological defense against these mass attacks. However, given enough beetles, even a live tree's defense mechanisms (*e.g.*, oleoresin and volatile organic compound emission, mobilization of resin flow, additional formation of resin directed towards the sites of beetle activity) can be exhausted (Bohlmann 2012; Raffa and Berryman 1987).

This species also faces threats from climate change, habitat loss from past and ongoing fire suppression activities, and the combined negative effects of these individual threats. Fire is one of the most important landscape-level disturbance processes within high-elevation whitebark pine forests (Agee 1993; Morgan and Murray 2001; Spurr and Barnes 1980) and is relevant to whitebark pine both as a stressor that can cause mortality of all life stages and as a mechanism that may affect forest succession (Arno 2001; Keane and Parsons 2010; Shoal *et al.* 2008). Fire regimes in whitebark pine systems are often characterized as being of mixed severity (Arno 2001, Campbell and Antos 2003; Larson 2009).

Habitat loss is anticipated to occur across whitebark pine range, with current habitats becoming unsuitable for the species as a result of both direct and indirect impacts from climate change (Aitken *et al.* 2008; Bartlein *et al.* 1997; Chang *et al.* 2014; Hamann and Wang 2006; Loehman *et al.* 2011; Rice *et al.* 2012; Schrag *et al.* 2007; Warwell *et al.* 2007). Researchers have hypothesized that there will be significant habitat loss as, (1) temperatures become so warm that

they exceed the thermal tolerance of whitebark pine and the species is unable to survive, (2) warmer temperatures favor other species of conifer that currently cannot compete with whitebark pine in cold high-elevation habitats, and (3) climate change alters the frequency and intensity of disturbances (e.g., fire, disease) to such an extent that whitebark pine cannot persist. In summary, the pace of predicted climate change could outpace many plant species' abilities to respond to concomitant habitat changes. Whitebark pine has the potential to be particularly vulnerable to warming temperatures because it is adapted to cool, high-elevation habitats (Service 2021).

Globally increasing trends in widespread tree mortality events will likely continue as climate change related variations in temperature and precipitation result in physiological stress, and extreme climate events including longer, hotter droughts may generate novel interactions among drought-stressed trees and additional stressors such as insects, disease, or fires (Airey and Taylor 2024; McDowell *et al.* 2022; Millar *et al.* 2007; van Mantgem *et al.* 2009). As a result of these threats, it is estimated that as of 2016, 51 percent of all standing whitebark pine trees were dead (Goeking and Izlar 2018). Most current management and research focus on producing and planting white pines (including whitebark pine) with genetic resistance to white pine blister rust, but also includes natural regeneration and silvicultural treatments, such as appropriate site selection and preparation, pruning, and thinning (Zeglen *et al.* 2010).

4. RECENT SECTION 7 CONSULTATIONS

On September 28, 2023, YNP received concurrence from the Service on the Whitebark Pine Conservation Plan (2023-0134631), which includes targeted actions in six core areas of YNP to support the goals of the *National Whitebark Pine Restoration Plan*. Yellowstone National Park committed to a comprehensive range of actions to conserve whitebark pine, including prevention, protection, research, plant material collection, restoration, and monitoring.

In May 2024, the Service issued a BO for the Old Faithful Water Treatment Project (2024-0027011) in YNP. The project resulted in the removal of 10 whitebark pine seedlings after the incorporation of design features, conservation measures and monitoring conditions to avoid and minimize impacts to whitebark pine trees. This activity resulted in the removal of a very small fraction of mature whitebark pine trees relative to the number that are known to occur within the project's action area, and led to trampling, crushing, and burial of some unknown number of seed, seedling, and sapling life stages.

In October 2024, the Service issued a programmatic BO for the Wildlife Fire Management Plan (2024-0136781) in YNP. The ten-year plan allocates approximately 300 acres a year for treatments within developed areas to treat hazard fuels, in addition to planning response to unplanned ignitions both inside and outside designated fire suppression zones. While many developed areas in YNP are not entirely suitable whitebark pine habitat, up to 3,000 acres of habitat occupied by whitebark pine may be impacted during the ten-year period of plan implementation. Cone bearing trees, and especially those identified as 'plus' trees, would be protected, wherever possible.

In November 2024, the Service issued BOs for the Rehabilitation of the Madison Junction Water System Phase II Project (2024-0140361) and the Replacement of Mammoth Wastewater Collection System Project (2025-0001684) in YNP. These projects will complete the updating and replacement of aging water source and wastewater treatment infrastructure in the Madison

Junction and Mammoth areas of YNP. Associated activities will result in the removal of five whitebark pine and may have sublethal impacts on an additional 32 individuals identified within the Madison Junction action area, and the removal of six whitebark pine and potential sublethal impacts on 27 individuals within the Mammoth action area.

In February 2025, the Service issued a BO for the Rehabilitation of the Canyon, Grant, and Old Faithful Wastewater Treatment and Collections systems (2025-0003485) in YNP. That project will complete the replacement and repair of existing sewer lines, maintenance facilities, lift stations, and manholes throughout the wastewater collection systems in the Canyon Village, Grant Village, and Old Faithful developed areas of YNP. Associated project activities will also result in direct removal of an estimated 849 whitebark pine as well as sublethal impacts to 2,285 whitebark pine individuals.

On March 20, 2025, YNP received a BO from the Service (2025-0038174) in response to the formal consultation for the effects to whitebark pine from the Grant Modular Housing Site #1 Rehabilitation Project. This was an initial stand-alone project to upgrade housing at one developed site in YNP. Following completion of this BO, YNP and the Service agreed to combine similar housing additions and upgrades to be addressed programmatically.

5. ENVIRONMENTAL BASELINE

Regulations implementing the ESA (50 CFR § 402.02) define the environmental baseline as the condition of the listed species or its designated critical habitat in the action area, without the consequences to the listed species or designated critical habitat caused by the proposed action. The environmental baseline includes the past and present impacts of all federal, state, or private actions and other human activities in the action area, the anticipated impacts of all proposed federal projects in the action that have already undergone formal or early section 7 consultation, and the impact of state or private actions which are contemporaneous with the consultation in process. The impacts to listed species or designated critical habitat from federal agency activities or existing federal agency facilities that are not within the agency's discretion to modify are part of the environmental baseline.

Action Area

The action area is defined at (50 CFR 402.02) as "all areas to be affected directly or indirectly by the federal action and not merely the immediate area involved in the action." The proposed actions will address deficiencies in the capacity and condition of employee housing at ten individual sites located within eight developed areas in YNP. Land use within the project areas consists of employee housing, parking lots, storage facilities, and administrative buildings.

The action area for the Project encompasses the sum of all site activities, including construction disturbance footprint and associated 33-foot buffers, totals approximately 87.08 acres. The purpose of the 33-foot buffer is to further protect whitebark pine where indirect effects could occur; for example, unintentional construction expansion, runoff, and/or the resulting deposition or erosion of sediment/soils. Small expansions to existing roadway and parking may add approximately 3,000-5,000 square feet (ft²) of additional impervious surface in some housing areas to accommodate parking spots and adjacent sidewalks.

Despite varying locations across YNP, the ten sites within the action area included in the Project are comparable based on disturbance levels, habitat types, and whitebark pine health. Each of the eight developed areas within YNP where Project activities are proposed contain similar levels of existing development, generally having some ground disturbance with adjacent undeveloped areas and existing access. Habitat types are also relatively similar across all sites, consisting of a mosaic of developed areas, mixed open and partially timbered areas, and more densely forested areas.

Status and Factors Affecting Whitebark Pine within the Action Area

Whitebark pine occurs on about 314,000 acres within YNP, either as a dominant portion of forests above 8,400 feet or a mixed understory component in lodgepole pine forests from 7,000 feet to 8,400 feet (Greater Yellowstone Coordinating Committee Whitebark Pine Subcommittee 2011; NPS 2024). During 2004 to 2015, botanists monitored 5,215 whitebark pines greater than 4.5 feet tall on 176 transects throughout the GYE. Across all age classes, about 26 percent of monitored trees died, with the highest mortality in trees greater than four inches diameter at breast height (DBH). Most mortality occurred during 2008 to 2011 after the abundance of native mountain pine beetles increased substantially due to above-average temperatures from 2006 to 2008 (Shanahan *et al.* 2016). The beetle outbreak appeared to wane after 2011, although beetle outbreaks have been observed in the GYE in 2021, 2022, and 2023. Data across the GYE, which includes YNP, show rust infection rates of 13 to 25 percent (Shanahan *et al.* 2017).

From 10 to 30 percent of whitebark pine trees in the GYE may have some level of genetic resistance to the white pine blister rust and survive infection. Geneticists identified rust resistant trees, called ‘plus’ trees, with discernable characteristics in six forests in the GYE with high blister rust infection rates. Ecologists began collecting cones from these trees and propagating seeds for use in restoration efforts, and fire managers were provided with the locations of ‘plus’ trees to protect them if possible. Although YNP has not been planting whitebark pines, some member agencies of the Whitebark Pine Subcommittee began planting blister rust-resistant seedlings in the GYE during the 2000s, averaging about 234 acres (95 hectares) per year through 2013. To date, YNP has identified 11 ‘plus’ trees in the Washburn Range, along the northern portion of Yellowstone Lake, on the Central Plateau west of Yellowstone Lake, and in the southern Absaroka Range east of Yellowstone Lake.

The suppression of wildland fires over many decades in some areas has resulted in conditions whereby more frequent, bigger, and hotter wildfires could be unfavorable for whitebark pine survival, reducing cone production and the likelihood of natural seedling establishment (Greater Yellowstone Coordinating Committee Whitebark Pine Subcommittee 2011, Greater Yellowstone Whitebark Pine Monitoring Working Group 2020). However, studies suggest fire suppression has had minor impacts on the dynamics of most subalpine forests in the Yellowstone area (Meyer and Pierce 2003, Whitlock *et al.* 2003). Given the statutory and policy objectives for YNP, 91 percent (2 million acres) of which is managed as wilderness, managers allow fire to carry out its ecological role while using suppression strategies with minimal impacts to YNP resources when necessary. Thus, no special fire management efforts are implemented in whitebark pine stands other than the implementation of minimum impact tactics and the protection of ‘plus’ trees and whenever possible cone bearing trees.

All ten sites encompassed by the action area are predominantly occupied by mature lodgepole pine, with younger whitebark pine in the understory. The status and health of whitebark pine in

the action area are comparable to the overall health of the whitebark pine in the larger GYE. Specifically, whitebark pine in the action area are impacted by the same threats and concerns. While no beetle infestations or blister rust were documented by the YNP staff during whitebark pine surveys, the areas directly disturbed by the Project may have fewer or local patches of whitebark pine regeneration due to their locations in developed areas within YNP. The Service still recommends measures to both monitor for and minimize the spread of beetle infestations and blister rust within the action area for the Project.

6. EFFECTS OF THE ACTION

In accordance with 50 CFR § 402.02, effects of the action are all consequences to listed species or critical habitat that are caused by the proposed action, including the consequences of all other activities that are caused by the proposed action but that are not part of the action. A consequence is caused by the proposed action if it would not occur but for the proposed action and it is reasonably certain to occur. Effects of the action may occur later in time and may include consequences occurring outside the immediate area involved in the action.

Effects of the action are a reasonable prediction of the likely reaction of, and biological effect to, individuals of a species to the environmental changes brought about by implementation of the chosen proposed action. It is not an exploration of alternatives to the proposed action. As with any prediction of a species' response to environmental impacts, there are many uncertainties associated with it. The prediction must be a reasoned prediction that is informed by science (if available). But because scientific literature reports on the results of controlled experiments and purposefully restricts its findings to the conditions and circumstances of the study, its findings can only be used to inform a predicted result from a future proposed action—it cannot determine the outcome with certainty. Therefore, additional information from observations on other species, from other environments, and based on the professional judgment of biologists familiar with the species, also plays a role in arriving at a reasoned prediction.

Surveys for whitebark pine have been conducted by staff at YNP since 2004, and managers are committed to mortality prevention and monitoring of the species. This includes protection, restoration of whitebark pine, and plant material collection. For the Project, YNP staff conducted surveys for whitebark pine at each of the ten sites. Sites with smaller construction footprints were surveyed completely, while sites with larger construction footprints were surveyed partially due to program and personnel constraints. In some instances, recent surveys at adjacent sites with similar conditions were incorporated to estimate whitebark pine at proposed sites. Estimates were calculated for partially surveyed sites based on whitebark pine densities across three categories of tree density (developed/low, mixed/medium, and forested/high). Resulting densities were applied to the remaining areas for each cover class to estimate total number of whitebark pine at each site (NPS 2025). In surveyed areas, whitebark pine were classified as seedlings (<1.37 meters tall), saplings (>1.37 meters tall with cones absent), or mature (>1.37 meters tall with cones present). To calculate lethal versus sublethal impacts, surveys also counted or estimated the total number of individual whitebark pines inside construction areas, and within the surrounding 33-foot buffers.

An estimated 13,172 seedlings, 2,491 saplings, and one mature whitebark pine were calculated within the total action area for the Project (Table 2). Of those totals, 10,690 whitebark pine (85% seedlings, 16% saplings) are anticipated to be directly removed from construction boundaries during Project implementation. An additional 4,973 individuals within the total

action area may experience sublethal impacts, primarily indirect impacts, from Project activities. One mature whitebark pine was identified in the 33-foot construction buffer at the West Entrance site and will be marked for protection during construction activities. No ‘plus’ or ‘elite’ trees were identified at any of the Project sites.

Housing Area	Seedlings	Saplings	Mature trees	Lethal Impacts	Sublethal Impacts	Total WBP Impacted
Canyon Junction - Boneyard	3,633	508	0	2,120	2,022	4,142
Canyon Junction - Neighborhood Circle	7,193	476	0	5,979	1,689	7,668
Canyon Junction - Delaware North Dorm	45	13	0	49	9	58
Grant Village - Site #3	251	494	0	447	298	745
Madison Junction	114	21	0	92	43	135
Norris Junction	1675	811	0	1,698	788	2,486
Northeast Entrance	10	3	0	2	11	13
Old Faithful	0	9	0	6	3	9
South Entrance	236	150	0	278	107	385
West Entrance	15	6	1	19	3	22
Total	13,172	2,491	1	10,690	4,973	15,663

Table 2. Estimated effects of Parkwide Housing Project to whitebark pine by age class and lethal versus sublethal impacts.

The proposed Project may adversely affect whitebark pine by disturbing soil, compacting soil, causing erosion from run-off from vegetation removal, potentially introducing noxious weeds, and directly injuring or removing whitebark pine individuals. An unknown number of unidentified seeds or seedlings present in the action area could be trampled, crushed and/or removed during Project implementation. Individuals of any age class could be exposed to fugitive dust, increased competition from introduced noxious/invasive species, increased habitat fragmentation and erosion. Unidentified saplings and mature individuals may be physically damaged during Project implementation. However, these adverse effects are highly localized, limited in scope and scale, and are minimized by the Project design features and conservation measures incorporated by YNP.

Prior to construction activities, comprehensive site surveys will be conducted by YNP staff to identify all whitebark pine individuals and stands, and to mark trees when appropriate to minimize disturbance and damage. Heavy equipment will be used sparingly or avoided in stands

of whitebark pine, and equipment will be washed before and after leaving the site to minimize introduction or spread of *Ribes* and prevent the spread of invasive species, pathogens, and pests. Herbicide spot treatments will be minimally used to control invasive plants, using standard avoidance buffers around whitebark pines. Creation of dust will be minimized and mitigated where possible. By educating staff and contractors to identify, mark, and avoid whitebark pine where possible in the action area, effects to whitebark pine will be reduced.

The sum of activities associated with the Project across the action area is not expected to result in population-scale decline or to impact the recovery of whitebark pine across its range. Project activities are aligned with developed areas within YNP, and associated actions are not expected to impact reproductive-aged trees. While one mature whitebark pine was identified in initial surveys, it is not located within a construction footprint and will be marked and protected. Additional effects of the action are offset by a variety of conservation and recovery efforts enacted throughout YNP, including planting of whitebark pine from nursery stock and protection of identified 'plus' and 'elite' trees. Areas temporarily impacted may be naturally recolonized by whitebark pine via seed dispersal by Clark's nutcracker or from seeds already present in soils within the Project area.

7. CUMULATIVE EFFECTS

Cumulative effects are those "effects of future state or private activities, not involving federal activities, that are reasonably certain to occur within the action area" considered in this PBO (50 CFR § 402.02). Future federal actions that are separate from the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA. The Service is not aware of any future state, tribal, local, or private actions that are reasonably certain to occur within the action area at this time; therefore, no cumulative effects are anticipated.

This consultation will be incorporated into the baseline of future completed consultations. This Project, when added to the existing activities in the YNP and across the species listed range, will not result in a local, population level, or range wide decline to whitebark pine nor will it preclude the ability of the species to recover.

8. CONCLUSION

Regulations direct the Service to evaluate whether a proposed action is likely to jeopardize the continued existence of threatened or endangered species. The continued existence of a listed species depends upon the fate of the populations that comprise them and the continued existence of a population is determined by the fate of individuals that comprise the population. That is, the abundance, reproduction, and distribution of a given species depends upon the collective performance of populations within the geographic extent of the species in the wild. Population performance is typically measured by rates of increase or decrease and is derived as a function of an individual's ability to live, die, grow, mature, and reproduce.

After reviewing the current status of whitebark pine, the environmental baseline for the action area, the effects of the proposed action, and the cumulative effects, it is the Service's biological opinion that the Project is not likely to jeopardize the continued existence of the whitebark pine. The anticipated level of whitebark pine removal caused by the proposed action will not appreciably reduce the overall population, reproduction, and distribution of whitebark pine

throughout its range.

We base this conclusion on the following:

1. The primary stressors to whitebark pine range-wide are the high incidence of the non-native white pine blister rust, large intense fires in whitebark pine habitat, mountain pine beetle (Logan *et al* 2010; Raffa and Berryman 1987), and the impacts of climate change. These primary stressors also act on whitebark pine in the Middle Rockies analysis unit, and the subunit where the Project occurs within the whole range of the species as discussed in the SSA (Service 2021).
2. The Project will remove and/or damage individual trees on a localized scale but will have little impact on whitebark pine at a landscape or ecosystem scale.
3. Many trees will remain on the landscape, including trees that are resistant to white pine blister rust, the primary threat to the species.
4. Past human activities, like those proposed, have not jeopardized the persistence of whitebark pine stands and populations.
5. Many agencies and other organizations (*e.g.*, USFS, NPS, Whitebark Pine Ecosystem Foundation) are undertaking restoration activities (*e.g.*, planting rust-resistant trees) to improve the species' condition, and these activities are expected to continue.
6. The NPS and YNP are committed to minimizing impacts to whitebark pine through Project design features.
7. Range wide, whitebark pine occurs across an estimated 10.2 million acres in the United States. The 10,695 whitebark pine individuals on 87.08 acres directly affected by this Project account for a minute portion of the individuals that occur across the entire species' range. The potential for sublethal impacts of the project on 4,970 whitebark pine individuals will be minimized by following all recommended conservation measures.
8. Of the 314,000 acres of whitebark pine in YNP, the direct removal of 10,695 individuals over 87.08 acres would not contribute to a decline in species presence at a local population level or at a larger population level that would reduce the likelihood of species persistence.
9. The action area contains habitat suitable for whitebark pine, which could be recolonized through seed dispersal by Clark's nutcrackers.

In making our conclusion, we considered that: the proposed action will affect a small number of individual trees and proportion of habitat occupied by whitebark pine within YNP, and less still on a listed range scale; proposed conservation measures are likely to further reduce adverse effects; most of the effects will occur in previously disturbed areas; no individuals impacted are known 'plus' or 'elite' trees; and none of the actions will exacerbate stressors to the species. While adverse effects will occur to some individual whitebark pine trees, impacts will be highly localized and do not rise to landscape-level effects. The conclusions of this PBO are based on full implementation of the Project as described in the Description of the Proposed Action section of this document, including any conservation measures that were incorporated into the Project design.

9. INCIDENTAL TAKE STATEMENT

Section 9 of the ESA and federal regulations pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without special exemption. Take of a listed species defined in section 3 of the ESA means to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. "Harm" is further

defined (50 CFR § 17.3) as an act which actually kills or injures wildlife and which may include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering. “Harass” is defined (50 CFR § 17.3) as intentional or negligent act or omission which creates the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding, or sheltering. “Incidental take” is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2) of the ESA, taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the ESA provided that such taking is in compliance with the terms and conditions of this incidental take statement.

Sections 7(b)(4) and 7(o)(2) of the ESA generally do not apply to listed plant species. However, the section 4(d) rule for whitebark pine prohibits the following activities unless otherwise authorized or permitted: (a) import or export of the species; (b) delivery, receipt, transport, or shipment of the species in interstate or foreign commerce in the course of commercial activity; (c) sale or offer for sale of the species in interstate or foreign commerce; (d) removal and reduction to possession of the species from areas under federal jurisdiction; (e) malicious damage or destruction of the species on any area under federal jurisdiction; and (f) removal, cutting, digging up, or damage or destruction of the species on any other area in knowing violation of any law or regulation of any state or in the course of any violation of a state criminal trespass law. Under the 4(d) rule, the exceptions to the prohibitions include: (a) activities authorized by a permit under 50 CFR §17.72; (b) forest-management, restoration, or research-related activities conducted or authorized by the federal agency with jurisdiction over the land where the activities occur; (c) removal, cutting, digging up, or damage or destruction of the species on areas under federal jurisdiction by any qualified employee or agent of the Service or state conservation agency that is operating a conservation program pursuant to the terms of a cooperative agreement with the Service in accordance with section 6(c) of the ESA, who is designated by that agency for such purposes, when acting in the course of official duties; and (d) collection of whitebark pine seeds from areas under federal jurisdiction for Tribal ceremonial use or traditional Tribal consumption if the collection is conducted by members of federally recognized Tribes and does not violate any other applicable laws and regulations (87 FR 76882 [December 15, 2022]). Therefore, while there is no incidental take statement as part of this PBO, we have additional monitoring and reporting needs, described below.

10. REASONABLE AND PRUDENT MEASURES AND TERMS AND CONDITIONS

All conservation measures including avoidance and minimization measures, status surveys, biological and compliance monitoring, and reporting measures are incorporated herein by reference as reasonable and prudent measures and terms and conditions to address the incidental take of the whitebark pine. No additional reasonable and prudent measures were identified during the consultation.

By January 31st of each Project year, YNP will provide the Service with an annual report summarizing activities completed and tracking total acres and number of whitebark pine impacted. Should the total number of acres or number of whitebark pine impacted be higher than anticipated for any individual Project site, YNP and the Service will re-initiate consultation for the Project. After the proposed Project is completed, YNP will provide the Service with a final report describing the cumulative effects of the Project. This report should include all

conservation measures and recommendations implemented, as well as results of post-Project monitoring with an estimate of the number of individuals and acreage of whitebark pine damaged and/or removed by the Project.

11. CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the ESA directs federal agencies to utilize their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information.

1. Identify, test, and protect both active and potential ‘plus’ trees. In some instances, conservation and recovery of whitebark pine could be aided by even single, solitary trees, whether at the stand level or the landscape level depending on how widespread stressors have impeded the health of the whitebark pine in a particular area. Some whitebark pine trees are phenotypically resistant to blister rust, providing viable seeds sources for natural regeneration or cone collection for site rehabilitation.
2. Collect cones, and plant seedlings and/or directly sow whitebark pine seeds, especially those from ‘plus’ trees. Prioritize areas affected by the white pine blister rust, mountain pine beetle, wildfire, climate change, and natural disasters (*e.g.*, large, burned areas).
3. Support continued genetic research and development of whitebark pine seed orchards. Establish long-term monitoring plots to document whitebark pine cone production, natural disturbances (post fire response), climate change effects, and annual survivorship of restoration plantings. Continue to implement and as needed, initiate long-term monitoring to measure the status and trends of whitebark pine health across its range.
4. Develop a monitoring program in whitebark pine habitat to determine regeneration and recruitment success for whitebark pine planting areas and natural regeneration areas. Identify, model and map future results of whitebark pine inventories and create fine scale maps to identify and develop whitebark pine core areas for high-impact restoration. Microsites, site edaphic variables and competition from grasses and shrubs play a key role in recruitment of whitebark pine. Consider understanding these knowledge gaps before significant resources are invested into planting.
5. When designing and implementing the Project, avoid impacts that reduce reproduction or recruitment of whitebark pine into populations.
6. When designing and implementing the Project, consider, evaluate, and carry out opportunities to mitigate and offset the effects of global climate change.
7. Prior to Project implementation, inventory whitebark pine stands and monitor populations of Clark’s nutcracker providing the Service with signs of caching or other indications of Clark’s nutcracker presence in the Project area.
8. Engage and continue to work with partners on a National Restoration Plan for whitebark pine.

9. Seek new public educational opportunities concerning whitebark pine restoration and protection.
10. Encourage and work with public and private land managers, including non-profit organizations and landowners, to protect, restore, enhance, and manage habitat to maintain and expand suitable habitat for the whitebark pine, particularly within and adjacent to occupied areas.
11. Restore damaged, unhealthy, or extirpated whitebark pine trees and stands using propagation, screening, and planting seedlings, and removing competing conifers.

For the Service to be kept informed of actions minimizing or avoiding adverse effects or benefitting listed species or their habitats, the Service requests notification of the implementation of any conservation recommendations.

12. REINITIATION NOTICE

This concludes formal consultation on the Project in YNP. If more than 87.08 acres are directly impacted or more than 10,695 whitebark pine individuals are removed, additional consultation may be necessary. Similarly, if construction activities are not completed by September 2028 at any Project sites, additional consultation may be necessary. As provided in 50 CFR § 402.16, reinitiation of consultation is required where discretionary federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion; (2) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this biological opinion or written concurrence; or (3) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of anticipated impacts are exceeded, any operations causing such take must cease pending reinitiation.

Please refer to the consultation number, 2025-0084389 in future correspondence concerning this project. Should you require further assistance or if you have any questions, please contact Heather O'Brien at heather_obrien@fws.gov or by phone at (307) 996-8486.

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APPENDIX C

Geotechnical Engineering Report

Canyon Housing Upgrades



Geotechnical Engineering Report

**Canyon Housing Upgrades, YELL 309913 Predesign Services
Yellowstone National Park, WY**

November 23, 2020

Terracon Project No. C4205059

Prepared for:

DJ&A, P.C.

2000 Maple Street

Missoula, MT 59808

On behalf of

National Park Service

IMR – Northern Rockies MABO

Prepared by:

Terracon Consultants, Inc.

1392 13 Ave SW

Great Falls, MT 59404



November 23, 2020

DJ&A, P.C.
2000 Maple Street
Missoula, MT 59808



Attn: Mr. Chris Anderson, P.E.
P: (406) 721-4320
E: chris@djanda.com

Re: Geotechnical Engineering Report
Canyon Housing Upgrades, YELL 309913 Predesign Services
Canyon Housing Facility on Wolverine Loop
Yellowstone National Park, WY
Contract No. 140P1220D0002, Task Order No. 140P1421F0001
Terracon Project No. C4205059

Dear Mr. Chris Anderson:

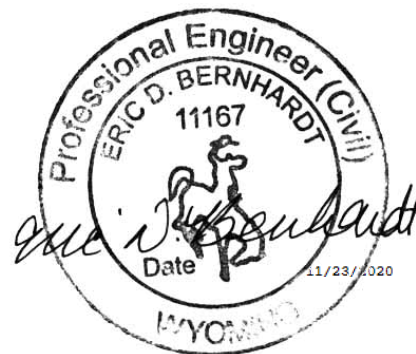
We have completed the Geotechnical Engineering services for the project referenced above. This study was performed in general accordance with Terracon Proposal No. PC4205059 dated October 13, 2020. This report presents the findings of the subsurface exploration and provides geotechnical recommendations concerning earthwork and the design and construction of foundations and floor slabs for the proposed project.

We appreciate the opportunity to be of service to you on this project. If you have any questions concerning this report or if we may be of further service, please contact us.

Sincerely,
Terracon Consultants, Inc.

A handwritten signature in black ink, appearing to read "Matthew D. Hoffmann".

Matthew D. Hoffmann, P.E.
Office Manager



Eric D. Bernhardt, P.E.
Senior Associate

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Note: This report was originally delivered in a web-based format. **Orange Bold** text in the report indicates a referenced section heading. The PDF version also includes hyperlinks which direct the reader to that section and clicking on the **GeoReport** logo will bring you back to this page. For more interactive features, please view your project online at client.terracon.com.

ATTACHMENTS

EXPLORATION AND TESTING PROCEDURES
PHOTOGRAPHY LOG
SITE LOCATION AND EXPLORATION PLANS
EXPLORATION RESULTS
SUPPORTING INFORMATION

Note: Refer to each individual Attachment for a listing of contents.

Geotechnical Engineering Report
Canyon Housing Upgrades, YELL 309913 Predesign Services
Canyon Housing Facility on Wolverine Loop
Yellowstone National Park, WY
Terracon Project No. C4205059
November 23, 2020

INTRODUCTION

This report presents the results of our subsurface exploration and geotechnical engineering services performed for the proposed Canyon Housing Upgrades to be located in Yellowstone National Park, WY at the Canyon Housing Facility on Wolverine Loop. The purpose of these services is to provide information and geotechnical engineering recommendations relative to:

- Subsurface soil conditions
- Groundwater conditions
- Site preparation and earthwork
- Frost considerations
- Foundation design and construction
- Floor slab design and construction
- Seismic site classification per IBC
- Lateral earth pressures

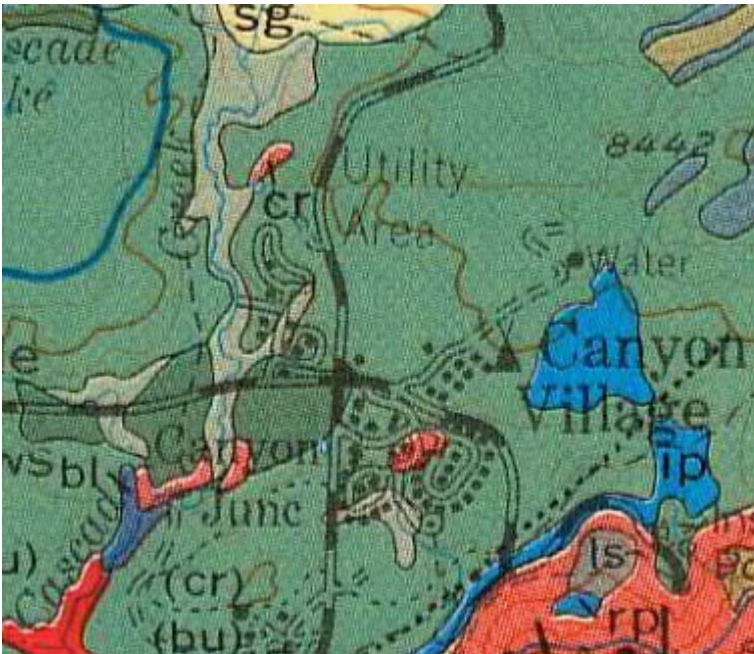
The geotechnical engineering Scope of Services for this project included the advancement of a single boring to a depth of approximately 9 feet below existing site grade.

Maps showing the site and boring location are shown in the **Site Location** and **Exploration Plan** sections, respectively. The results of the laboratory testing performed on soil samples obtained from the site during the field exploration are included on the boring log and as separate graphs in the **Exploration Results** section.

SITE CONDITIONS

The following description of site conditions is derived from our site visit in association with the field exploration and our review of publicly available geologic and topographic maps.

Item	Description
Parcel Information	The site is located within the employee housing area along Wolverine Loop at the Canyon Junction Facility of Yellowstone National Park, Wyoming. The project is located in the northwest quadrant of the intersection of Norris Canyon Road and Grand Loop Road (Approximate Lat. / Long. : 44.737188° N / 110.494691° W). See Site Location
Existing Improvements	Existing housing units are located to the immediate west of the boring, along with associated site access roads.

Item	Description
Current Ground Cover	Primarily trees and native grasses
Existing Topography	Generally flat, near Elevation 7908 feet based on DJ&A site survey
Geology	 Figure 1: Excerpt from Surficial Geologic Map of Yellowstone National Park (by the US Geological Survey 1972). The site is situated northwest of the Canyon Junction intersection within a primarily sand and gravel deposit (Pg) of layered sand and gravel material emplaced by outwash, alluvial fan or terrace deposits. Underlain by glacial till of the Pinedale age and bedrock of the Upper Basin Member Canyon flow and tuff of Sulphur Creek age.

We also collected photographs at the time of our field exploration program. Representative photos are provided in our [Photography Log](#).

PROJECT DESCRIPTION

Our initial understanding of the project was provided in our proposal, and was consistent with the details provided within the Request for Proposal and Description of Work provided by DJ&A on October 7, 2020, and our final understanding of the project conditions is as follows:

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Item	Description
Information Provided	We were provided with the following documents from DJ&A via e-mail between October 1 and 7, 2020: ■ Request for Qualifications dated October 1, 2020, which included a Description of Work for the Geotechnical Survey and Mapping Survey for Eight Sites within Yellowstone along with site layouts of each proposed site utilizing Google Earth Pro ■ Request for Price Proposal dated October 7, 2020, which included the above documents as well
Project Description	Proposed construction site for new employee housing
Proposed Structures	Size and quantity unknown at this time
Building Construction	Anticipated wood-framed construction utilizing frost-depth, continuous reinforced concrete foundations with potential concrete slab-on-grade floors
Finished Floor Elevation	Not provided at this pre-design phase, and likely to vary
Maximum Loads	Assuming lightly loaded structure with loads on the order of: ■ Walls: 1-3 kips per linear foot (klf) ■ Columns: 25 kips maximum ■ Slabs: 150 pounds per square foot (psf)
Grading/Slopes	Relatively flat

GEOTECHNICAL CHARACTERIZATION

We have developed a general characterization of the subsurface conditions based upon our review of the subsurface exploration, laboratory data, geologic setting and our understanding of the project. This characterization, termed GeoModel, forms the basis of our geotechnical calculations and evaluation of site preparation and foundation recommendations. Conditions encountered at the exploration point are indicated on the boring log. The boring log can be found in the **Exploration Results** section of this report.

As part of our analyses, we identified the following model layers within the subsurface profile. For a more detailed view of the model layer depth at the boring, refer to the boring log.

Model Layer	Layer Name	General Description
1	Topsoil	Organic matter, topsoil, grass, roots
2	Sand	Light brown, medium dense, some obsidian fragments and varying amounts of fines and gravels
3	Bedrock	Hard, basalt flow appearance within sample recovered, moderately weathered, poorly cemented, oxidized

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The boring was observed while drilling and immediately after completion for the presence and level of groundwater. Groundwater was not observed in the boring at the time of our exploration. The field investigation does not fully reflect seasonal or long-term groundwater conditions which will be influenced by precipitation, hydrologic impacts originating off-site, and other factors beyond the scope of this investigation. Therefore, groundwater levels during construction or at other times in the life of the structures may vary from the conditions indicated on the Log.

GEOTECHNICAL OVERVIEW

The near surface, silty sand could become unstable with typical earthwork and construction traffic, especially after precipitation events. The establishment of effective drainage should be completed early in the construction sequence and maintained throughout and following construction to avoid potential issues. If possible, grading operations should be performed during the warmer and drier times of the year. If grading is performed during the winter months, an increased risk for possible undercutting and replacement of unstable subgrade will persist. Additional site preparation recommendations, including subgrade improvement and fill placement, are provided in the **Earthwork** section.

The silty sand soils which form the bearing stratum for shallow foundations are generally non-plastic, granular exhibiting low potential for shrink-swell movements with changes in moisture. The **Shallow Foundations** section addresses support of the buildings bearing on properly prepared native silty sand soils. The **Floor Slabs** section addresses slab-on-grade support of the buildings, if selected to utilization.

The **General Comments** section provides an understanding of the report limitations.

EARTHWORK

Earthwork is anticipated to include clearing and grubbing, excavations, and fill placement. The following sections provide recommendations for use in the preparation of specifications for the work. Recommendations include critical quality criteria, as necessary, to render the site in the state considered in our geotechnical engineering evaluation for foundations and floor slabs.

Site Preparation

Prior to placing fill, existing vegetation and root mat should be removed. Complete stripping of the topsoil should be performed in the proposed building areas.

Performance of foundations bearing with the native silty sand subgrade will be heavily dependent upon quality earthwork operations and preparation of the bearing surface. Following stripping, foundation excavations should be conducted to base of anticipated footing elevation by means of

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excavation equipment operating from above and outside the limits of the subgrade to limit disturbance to the sand subgrade. Following excavation to footing bearing elevation, the sand (some gravels may be encountered based on the limited subsurface data obtained) subgrade surface should be scarified, moisture conditioned and compacted to a minimum of 98 percent of the maximum laboratory dry density value (per ASTM D698) to provide for a properly prepared bearing surface to receive foundation concrete. The bearing surface should be observed and tested by our Geotechnical Engineer to ensure that proper preparation to recover any disturbance to the subgrade has been conducted. It will be important to limit the potential for moisture increase to the subgrade following preparation, and concrete placement should be conducted as soon as possible following excavation to and acceptance of the bearing surface subgrade. Areas delineated during this subgrade observation that are not properly prepared, or are inconsistent with the anticipated subgrade conditions, should be corrected as directed by the Geotechnical Engineer. Excessively wet or dry material should either be removed and replaced with Structural Fill, or moisture conditioned and recompacted as directed by the Geotechnical Engineer.

Fill Material Types

Engineered fill required to achieve design grade should be classified as Structural Fill and general fill. Structural Fill is material used below (if needed due to overexcavation of unsuitable materials), or within 5 feet of structures. General fill is material used to achieve grade outside of these areas. Earthen materials used for Structural Fill and general fill should meet the following material property requirements:

Soil Type ¹	USCS Classification	Acceptable Parameters
Structural Fill (imported material)	GW, GP, SW, SP, and dual (GM/SM) symbols	100% passing 1 ½ inch size; 30-60% passing No. 4 screen, and no more than 12% passing No. 200 screen, the fines portion should have a maximum Liquid Limit and Plasticity Index of 25 and 10, respectively.
Crushed Base Course	GW, GP, SW, SP, and dual (GM/SM) symbols	¾ inch minus crushed aggregate base
On-Site Native Soils	SM	The on-site sand soils appear suitable for use as general fill , including site grade raising material and exterior backfill of foundations.

1. Structural and general fill should consist of approved materials free of organic matter and debris. Frozen material should not be used, and fill should not be placed on a frozen subgrade. A sample of each material type should be submitted to the Geotechnical Engineer for evaluation prior to use on this site.
2. Significant moisture conditioning of the native clay may be necessary to meet compaction requirements; this will require mechanical reduction in clay clod size (i.e. diskings, etc.) to a maximum 1-inch dimension to facilitate moisture conditioning; the necessary moisture adjustment will be difficult during wet/cold seasons.

Fill Compaction Requirements

Structural and general fill should meet the following compaction requirements.

Item	Structural Fill	General Fill
Maximum Lift Thickness	8 inches or less in loose thickness when heavy, self-propelled compaction equipment is used 4 to 6 inches in loose thickness when hand-guided equipment (i.e. jumping jack or plate compactor) is used	Same as Structural fill
Minimum Compaction Requirements ^{1, 2}	98% of max. below foundations 95% of max. above foundations and below floor slabs	92% of max.
Water Content Range ¹	Granular: -3% to +1% of optimum	As required to achieve min. compaction requirements
^{1.} Maximum density and optimum water content as determined by the standard Proctor test (ASTM D 698). ^{2.} If the granular material is a coarse sand or gravel, or of a uniform size, or has a low fines content, compaction comparison using local practices may be more appropriate. It should be noted that ASTM D698 allows for rock-correction of samples with up to 30% Retained on the 3/4" screen, but that this can lead to values not attainable in the field. ASTM allows for use of engineering judgement of field test strips. Local practice also has utilized successfully for control of the former ASTM D698 method of rock-replacement.		

Utility Trench Backfill

For low permeability subgrades, utility trenches are a common source of water infiltration and migration. Utility trenches penetrating beneath the buildings should be effectively sealed to restrict water intrusion and flow through the trenches, which could migrate below the building. The trench should provide an effective trench plug that extends at least 5 feet from the face of each of the building exteriors. The plug material should consist of cementitious flowable fill or low permeability clay. The trench plug material should be placed to surround the utility line. If used, the clay trench plug material should be placed and compacted at or above optimum water content range to limit potential for moisture infiltration by creating a lower permeability fill zone within the wetted clay.

Grading and Drainage

All grades must provide effective drainage away from the buildings during and after construction and should be maintained throughout the life of the structures. Water retained next to the buildings can result in soil movements greater than those discussed in this report. Greater movements can result in unacceptable differential floor slab and/or foundation movements, cracked slabs and walls, and roof leaks. Roofs should have gutters/drains with downspouts that discharge beyond the backfill zone, preferably onto splash blocks or other erosion resistant materials, at a distance of at least 10 feet from the buildings.

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Exposed ground should be sloped and maintained at a minimum 5 percent away from the buildings for at least 10 feet beyond the perimeter of the buildings. Locally, flatter grades may be necessary to transition ADA access requirements for flatwork. After building construction and landscaping have been completed, final grades should be verified to document effective drainage has been achieved. Grades around the structures should also be periodically inspected and adjusted, as necessary, as part of the structure's maintenance program. Where paving or flatwork abuts the structures, a maintenance program should be established to effectively seal and maintain joints and prevent surface water infiltration.

Earthwork Construction Considerations

Shallow excavations for the proposed structures are anticipated to be accomplished with conventional construction equipment. Upon completion of filling and grading, care should be taken to maintain the subgrade water content prior to construction of floor slabs. Construction traffic over the completed subgrades should be avoided. The site should also be graded to prevent ponding of surface water on the prepared subgrades or in excavations. Water collecting over or adjacent to construction areas should be removed. If the subgrade freezes, desiccates, saturates, or is disturbed, the affected material should be removed, or the materials should be scarified, moisture conditioned, and recompacted prior to floor slab construction.

As a minimum, excavations should be performed in accordance with OSHA 29 CFR, Part 1926, Subpart P, "Excavations" and its appendices, and in accordance with any applicable local, and/or state regulations.

Construction site safety is the sole responsibility of the contractor who controls the means, methods, and sequencing of construction operations. Under no circumstances shall the information provided herein be interpreted to mean Terracon is assuming responsibility for construction site safety, or the contractor's activities; such responsibility shall neither be implied nor inferred.

Construction Observation and Testing

The earthwork efforts should be monitored under the direction of the Geotechnical Engineer. Monitoring should include documentation of foundation subgrade preparation, and subgrade mitigation of areas delineated to require mitigation based on review of foundation and slab subgrade conditions.

Each lift of compacted fill should be tested, evaluated, and reworked, as necessary, until approved by the Geotechnical Engineer prior to placement of additional lifts. Each lift of fill should be tested for density and water content. Based on the planned foundation construction it is recommended that testing frequencies as below be utilized:

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- Minimum of one test per isolated (spread) footing, for each lift
- Minimum one test per 50 linear feet of backfill, per lift of foundation backfill
- Minimum of one test for every 500 square feet of compacted fill in the building slab areas
- Minimum one test per lift off compacted utility trench plug

In areas of foundation excavations, the bearing subgrade should be evaluated under the direction of the Geotechnical Engineer. If unanticipated conditions are encountered, the Geotechnical Engineer should prescribe mitigation options.

In addition to the documentation of the essential parameters necessary for construction, the continuation of the Geotechnical Engineer into the construction phase of the project provides the continuity to maintain the Geotechnical Engineer's evaluation of subsurface conditions, including assessing variations and associated design changes.

SHALLOW FOUNDATIONS

The primary geotechnical considerations for the site are to provide reliable bearing within the native sand deposit, while limiting the potential for differential settlement of the lightly loaded residential structures. The native silty sand, which is the predominant subsurface material encountered within the upper 9 feet of the soil profile, varies from medium dense to very dense exhibiting moderate to high shear strength characteristics based on correlations with Standard Penetration Test (SPT) N-values and limited potential for load induced settlements. With proper preparation of the foundation bearing surface, as described within the **Earthwork** section, reliable bearing support and limited settlement of new foundation can be anticipated at the site.

For our analysis, we utilized the profile encountered at Boring B-05 as the controlling subsurface profile with medium dense to very dense silty sand extending from a nominal topsoil layer to approximately bedrock encountered at 9 feet below existing ground surface. For analysis of bearing capacity, we have utilized Gibbs, Holtz, and Meyerhof (1956) correlation between standard penetration resistance, relative density and phi angle for sands to develop our strength parameters. Based on STP N-value of approximately 50 blows per foot at 5 feet below existing grade, we have utilized a cohesion of 0 psf (non-plastic, granular), and a phi angle of 34 degrees from the correlation. Our settlement analysis has been conducted using Schmertmann and Hartman (1978) using strain influence factors semiempirical analysis methods. Therefore, if the native silty sand at the site has been prepared in accordance with the requirements noted in **Earthwork**, the following design parameters are applicable for shallow foundations.

Design Parameters – Compressive Loads

Item	Description
Maximum Allowable Net Bearing Pressure ^{1, 2}	2,500 psf (continuous, strip footings) 3,000 psf (isolated, spread footings)
Required Bearing Stratum ³	Properly prepared and compacted, native silty sand or Structural Fill replacement zone if needed for unsuitable subgrade zones
Minimum Foundation Dimensions	Columns: 36 inches Continuous: 18 inches
Ultimate Passive Resistance ⁴ (equivalent fluid pressures)	400 pcf (native sand backfill) 500 pcf (Structural Fill backfill)
Ultimate Coefficient of Sliding Friction ⁵	0.50 (native sand) 0.70 (Structural Fill)
Minimum Embedment below Finished Grade ⁶	Exterior footings: 48 inches Interior footings in heated areas: 24 inches
Estimated Total Settlement from Structural Loads ²	About ½ inch
Estimated Differential Settlement ^{2, 7}	About ½ of total settlement

1. Assumes proper preparation of bearing surface in accordance with **Site Preparation**. Based on a minimum factor of safety of 3.
2. Values provided are for maximum loads noted in **Project Description**.
3. Unsuitable or soft soils should be over-excavated and replaced per the recommendations presented in the **Earthwork**.
4. Use of passive earth pressures require the sides of the excavation for the spread footing foundation to be nearly vertical and the concrete placed neat against these vertical faces or that the footing forms be removed and compacted structural fill be placed against the vertical footing face. A minimum factor of safety of 2 should be applied to ultimate values.
5. Can be used to compute sliding resistance where foundations are placed on suitable soil/materials. Should be neglected for foundations subject to net uplift conditions.
6. Embedment necessary to minimize the effects of frost and/or seasonal water content variations. For sloping ground, maintain depth below the lowest adjacent exterior grade within 5 horizontal feet of the structure, also application of a minimum factor of safety of 2 should be utilized.
7. Differential settlement and resultant deflection profile are as estimated for given column spacing or a maximum spacing of 50 feet.

Foundation Construction Considerations

As noted in **Earthwork**, the footing excavations should be evaluated under the direction of the Geotechnical Engineer. The base of all foundation excavations should be free of water and loose soil, prior to placing concrete. Concrete should be placed soon after excavating to reduce bearing soil disturbance. Care should be taken to prevent wetting or drying of the bearing materials during

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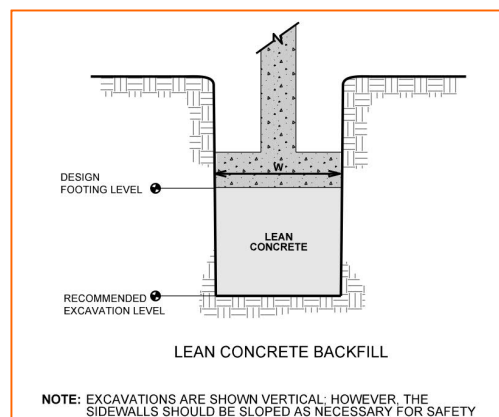
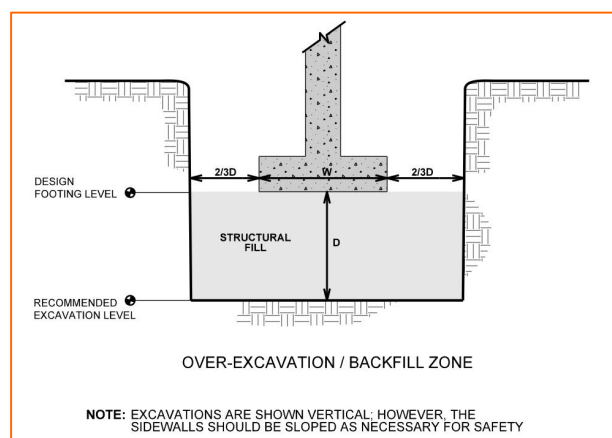
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construction. Excessively wet or dry material or any loose/disturbed material in the bottom of the footing excavations should be removed/reconditioned before foundation concrete is placed.

If unsuitable bearing soils are encountered at the base of the planned footing excavation, the excavation should be extended deeper to suitable soils, and the footings could bear directly on these soils after recovery of any disturbance by compaction at the lower level, replacement Structural Fill compacted as recommended in the **Earthwork** section to base of footing elevation, or on lean concrete backfill placed in the excavations. These methods for replacement are illustrated on the sketches below.



SEISMIC CONSIDERATIONS

The seismic design requirements for buildings and other structures are based on Seismic Design Category. Site Classification is required to determine the Seismic Design Category for a structure. The Site Classification is based on the upper 100 feet of the site profile defined by a weighted average value of either shear wave velocity, standard penetration resistance, or undrained shear strength in accordance with Section 20.4 of ASCE 7 and the International Building Code (IBC).

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Based on the soil properties encountered at the site and as described on the exploration logs and results, it is our professional opinion that the **Seismic Site Classification is C**. Subsurface explorations at this site were extended to a maximum depth of 21.5 feet. The site properties below the boring depth to 100 feet were estimated based on our experience and knowledge of geologic conditions of the general area. Additional deeper borings or geophysical testing may be performed to confirm the conditions below the current boring depth. A Peak Ground Acceleration (PGA) coefficient of 0.47g is expected for a 2425 year (2% in 50 years) interval based on United States Geological Survey Unified Hazard Tool (<https://earthquake.usgs.gov/hazards/interactive/>).

FLOOR SLABS

Performance of slab-on-grades will be heavily dependent upon quality earthwork operations, and preparation of subgrade as discussed previously in this report. Design parameters for floor slabs assume the requirements for **Earthwork** have been followed. Specific attention should be given to positive drainage away from the structure and positive drainage of the aggregate base beneath the floor slab.

Floor Slab Design Parameters

Item	Description
Floor Slab Support ¹	Properly prepared native silty sand and a minimum of 6 inches of crushed base course ²
Estimated Modulus of Subgrade Reaction ³	150 pounds per square inch per inch (psi/in) for point loads

1. Floor slabs should be structurally independent of building footings or walls to reduce the possibility of floor slab cracking caused by differential movements between the slab and foundation.
2. Crushed aggregate base course in accordance with The Standard Specifications for the Construction of Roads and Bridges on Federal Highway Projects (FP-14) Table 703-2, Grade E (Base)
3. Modulus of subgrade reaction is an estimated value based upon our experience with the subgrade condition, the requirements noted in **Earthwork**, and the floor slab support as noted in this table. It is provided for point loads. For large area loads the modulus of subgrade reaction would be lower.

The use of a vapor retarder should be considered beneath concrete slabs on grade covered with wood, tile, carpet, or other moisture sensitive or impervious coverings, or when the slab will support equipment sensitive to moisture. When conditions warrant the use of a vapor retarder, the slab designer should refer to ACI 302 and/or ACI 360 for procedures and cautions regarding the use and placement of a vapor retarder.

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Saw-cut control joints should be placed in the slab to help control the location and extent of cracking. For additional recommendations, refer to the ACI Design Manual. Joints or cracks should be sealed with a water-proof, non-extruding compressible compound specifically recommended for heavy duty concrete pavement and wet environments.

Where floor slabs are tied to perimeter walls or turn-down slabs to meet structural or other construction objectives, our experience indicates differential movement between the walls and slabs will likely be observed in adjacent slab expansion joints or floor slab cracks beyond the length of the structural dowels. The Structural Engineer should account for potential differential settlement through use of sufficient control joints, appropriate reinforcing or other means.

Floor Slab Construction Considerations

Finished subgrade, within and for at least 5 feet beyond the floor slab, should be protected from traffic, rutting, or other disturbance and maintained in a relatively moist condition until floor slabs are constructed. If the subgrade should become damaged or desiccated prior to construction of floor slabs, the affected material should be removed and Structural Fill should be added to replace the resulting excavation. Final conditioning of the finished subgrade should be performed immediately prior to placement of the floor slab support course.

The Geotechnical Engineer should approve the condition of the floor slab subgrades immediately prior to placement of the floor slab support course, reinforcing steel, and concrete. Attention should be paid to high traffic areas that were rutted and disturbed earlier, and to areas where backfilled trenches are located.

LATERAL EARTH PRESSURES

Design Parameters

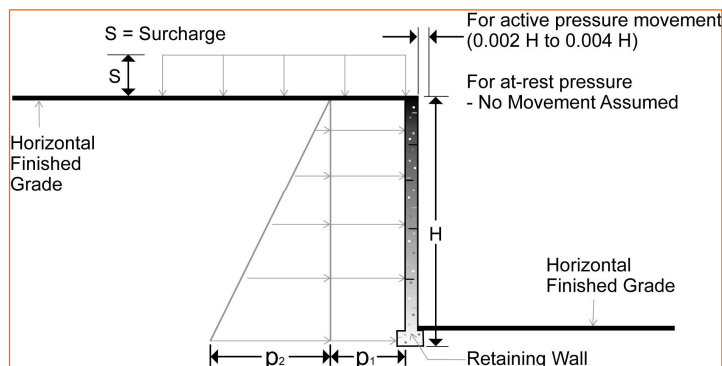
Structures with unbalanced backfill levels on opposite sides should be designed for earth pressures at least equal to values indicated in the following table. Earth pressures will be influenced by structural design of the walls, conditions of wall restraint, methods of construction and/or compaction and the strength of the materials being restrained. Two wall restraint conditions are shown in the diagram below. Active earth pressure is commonly used for design of free-standing cantilever retaining walls and assumes wall movement. The "at-rest" condition assumes no wall movement and is commonly used for basement walls, crawlspace (frost-depth foundation) walls, or other walls restrained at the top. The recommended design lateral earth pressures do not include a factor of safety and do not provide for possible hydrostatic pressure on the walls (unless stated).

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Earth Pressure Conditions	Coefficient for Backfill Type	Equivalent Fluid Density (pcf)	Surcharge Pressure, p_1 (psf)	Earth Pressure, p_2 (psf)
Active (K_a)	Structural Fill - 0.26	35	$(0.26)S$	$(35)H$
	Native Sand - 0.28	32	$(0.28)S$	$(32)H$
At-Rest (K_o)	Structural Fill - 0.42	55	$(0.42)S$	$(55)H$
	Native Sand - 0.44	50	$(0.44)S$	$(50)H$
Passive (K_p)	Structural Fill - 3.8	500	---	---
	Native Sand - 3.5	400	---	---

Applicable conditions to the above include:

- For active earth pressure, wall must rotate about base, with top lateral movements of about $0.002 H$ to $0.004 H$, where H is wall height
- For passive earth pressure to develop, wall must move horizontally to mobilize resistance
- Uniform surcharge, where S is surcharge pressure
- In-situ soil backfill weight a maximum of 115 pcf (native sand soils), 130 pcf (structural fill)
- Backfill placed in horizontal lifts and compacted between 95 and 98 percent of standard Proctor maximum dry density
- Loading from heavy compaction equipment is not included
- No hydrostatic pressures acting on wall
- No dynamic loading
- No safety factor included
- Ignore passive pressure in frost zone

Backfill placed against structures should consist of granular soils or low plasticity cohesive soils. For the granular values to be valid, the granular backfill must extend out and up from the base of

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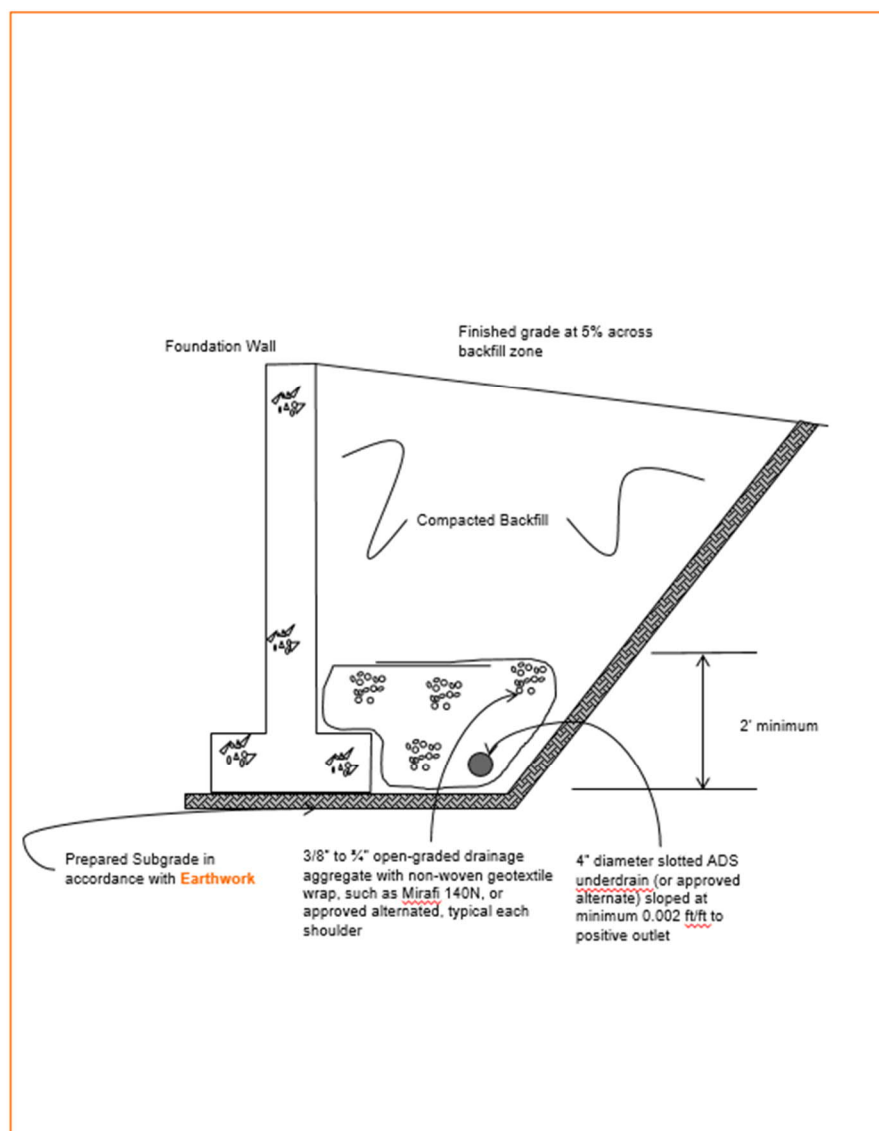
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the wall at an angle of at least 45 and 60 degrees from vertical for the active and passive cases, respectively.

Subsurface Drainage for Below-Grade Walls

A perforated rigid plastic drain line installed behind the base of walls and extending below adjacent grade is recommended to prevent hydrostatic loading on the foundation walls. The invert of a drain line around a below-grade building area or exterior retaining walls should be placed near foundation bearing level as shown in the detail below. The drain line should be sloped to provide positive gravity drainage to daylight or to a sump pit and pump.



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FROST CONSIDERATIONS

The soils on this site are frost susceptible, and small amounts of water can affect the performance of the slabs on-grade and sidewalks. Exterior slabs should be anticipated to heave during winter months. If frost action needs to be eliminated in critical areas, we recommend the use of non-frost susceptible (NFS) fill or structural slabs (for instance, structural stoops in front of building doors). Placement of NFS material in large areas may not be feasible; however, the following recommendations are provided to help reduce potential frost heave:

- Provide surface drainage away from the buildings and slabs, and toward the site storm drainage system.
- Install drains around the perimeter of the buildings, stoops, below exterior slabs, and connect them to the storm drainage system.
- Grade clayey subgrades, so groundwater potentially perched in overlying more permeable subgrades, such as sand or aggregate base, slope toward a site drainage system.
- Place NFS fill as backfill beneath slabs critical to the project.
- Place a 3 horizontal to 1 vertical (3H:1V) transition zone between NFS fill and other soils.
- Place NFS materials in critical sidewalk areas.

As an alternative to extending NFS fill to the full frost depth, consideration can be made to placing extruded polystyrene or cellular concrete under a buffer of at least 2 feet of NFS material.

CORROSIVITY

The table below lists the results of laboratory soluble sulfate, electrical resistivity, and pH testing. The values may be used to estimate potential corrosive characteristics of the on-site soils with respect to contact with the various underground materials which will be used for project construction.

Corrosivity Test Results Summary					
Boring	Sample Depth (feet)	Soil Description	Soluble Sulfate (%)	Electrical Resistivity ¹ (Ω-cm)	pH
B-05	2.5	Silty Sand (SM)	0.0013	25,000	7.1

1. Electrical resistivity was performed on a saturated sample

Results of water-soluble sulfate testing indicate that samples of the on-site soils have an exposure class of S0 when classified in accordance with Table 19.3.1.1 of the American Concrete Institute

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(ACI) Design Manual. Concrete should be designed in accordance with the provisions of the ACI Design Manual, Section 318, Chapter 19.

GENERAL COMMENTS

Our analysis and opinions are based upon our understanding of the project, the geotechnical conditions in the area, and the data obtained from our site exploration. Natural variations will occur between exploration point locations or due to the modifying effects of construction or weather. The nature and extent of such variations may not become evident until during or after construction. Terracon should be retained as the Geotechnical Engineer, where noted in this report, to provide observation and testing services during pertinent construction phases. If variations appear, we can provide further evaluation and supplemental recommendations. If variations are noted in the absence of our observation and testing services on-site, we should be immediately notified so that we can provide evaluation and supplemental recommendations.

Our Scope of Services does not include either specifically or by implication any environmental or biological (e.g., mold, fungi, bacteria) assessment of the site or identification or prevention of pollutants, hazardous materials or conditions. If the owner is concerned about the potential for such contamination or pollution, other studies should be undertaken.

Our services and any correspondence or collaboration through this system are intended for the sole benefit and exclusive use of our client for specific application to the project discussed and are accomplished in accordance with generally accepted geotechnical engineering practices with no third-party beneficiaries intended. Any third-party access to services or correspondence is solely for information purposes to support the services provided by Terracon to our client. Reliance upon the services and any work product is limited to our client, and is not intended for third parties. Any use or reliance of the provided information by third parties is done solely at their own risk. No warranties, either express or implied, are intended or made.

Site characteristics as provided are for design purposes and not to estimate excavation cost. Any use of our report in that regard is done at the sole risk of the excavating cost estimator as there may be variations on the site that are not apparent in the data that could significantly impact excavation cost. Any parties charged with estimating excavation costs should seek their own site characterization for specific purposes to obtain the specific level of detail necessary for costing. Site safety, and cost estimating including, excavation support, and dewatering requirements/design are the responsibility of others. If changes in the nature, design, or location of the project are planned, our conclusions and recommendations shall not be considered valid unless we review the changes and either verify or modify our conclusions in writing.

ATTACHMENTS

EXPLORATION AND TESTING PROCEDURES

Field Exploration

Number of Borings	Boring Depth (feet)	Planned Location
1	9.1	Planned building upgrade areas

Boring Layout and Elevations: Unless otherwise noted, Terracon personnel provided the boring layout. Coordinates were obtained with a handheld GPS unit (estimated horizontal accuracy of about ± 10 feet) and elevation was provided by DJ&A as determined during site survey activities.

Subsurface Exploration Procedures: Our exploration was completed on October 19, 2020, when we advanced the boring with a subcontracted, truck-mounted, Mobile B-57 drill rig operated by Boland Drilling using continuous-flight, hollow-stem augers. In general, four samples were obtained in the upper 10 feet of the boring. In the split-barrel sampling procedure, a standard 2-inch outer diameter split-barrel sampling spoon was driven into the ground by a 140-pound automatic hammer falling a distance of 30 inches. The number of blows required to advance the sampling spoon the last 12 inches of a normal 18-inch penetration is recorded as the Standard Penetration Test (SPT) resistance value. The SPT resistance values, also referred to as N-values, are indicated on the boring log at the test depths. A 3-inch O.D. split-barrel sampling spoon with 2.5-inch I.D. ring-lined sampler was used for sampling in the upper 7 feet. Ring-lined, split-barrel sampling procedures are similar to standard split spoon sampling procedure; however, blow counts are typically recorded for 6-inch intervals for a total of 12 inches of penetration. We observed and recorded groundwater levels during drilling and sampling. For safety purposes, the boring was backfilled with auger cuttings after completion.

The sampling depths, penetration distances, and other sampling information were recorded on the field boring log. The samples were placed in appropriate containers and taken to our soil laboratory for testing and classification by a Geotechnical Engineer. Our exploration team prepared a field boring log as part of the drilling operations. This field log included visual classifications of the materials encountered during drilling and our interpretation of the subsurface conditions between samples. A final boring log was prepared from the field log. The final boring log represents the Geotechnical Engineer's interpretation of the field log and include modifications based on observations and tests of the samples in our laboratory.

Laboratory Testing

The project engineer reviewed the field data and assigned laboratory tests to understand the engineering properties of the various soil strata, as necessary, for this project. Procedural standards noted below are for reference to methodology in general. In some cases, variations to methods were applied because of local practice or professional judgment. Standards noted below

Geotechnical Engineering Report

Canyon Housing Upgrades, YELL 309913 Predesign Services

Yellowstone National Park, WY

November 23, 2020 ■ Terracon Project No. C4205059



include reference to other, related standards. Such references are not necessarily applicable to describe the specific test performed.

- ASTM D2216 Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
- ASTM D4318 Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
- ASTM D422 Standard Test Method for Particle-Size Analysis of Soils

The laboratory testing program included examination of soil samples by an engineer. Based on the material's texture and plasticity, we described and classified the soil samples in accordance with the Unified Soil Classification System.

Other Testing: Soil chemistry (minimum laboratory soil resistivity, pH, and soluble sulfate content)

PHOTOGRAPHY LOG



View looking west at Boring B-05



View looking north at Boring B-05



View looking east at Boring B-05

SITE LOCATION AND EXPLORATION PLANS

Contents:

Site Location Plan

Exploration Plan

Note: All attachments are one page unless noted above.

SITE LOCATION

Canyon Housing Upgrades, YELL 309913 Predesign Services
Yellowstone National Park, WY
November 23, 2020 ■ Terracon Project No. C4205059

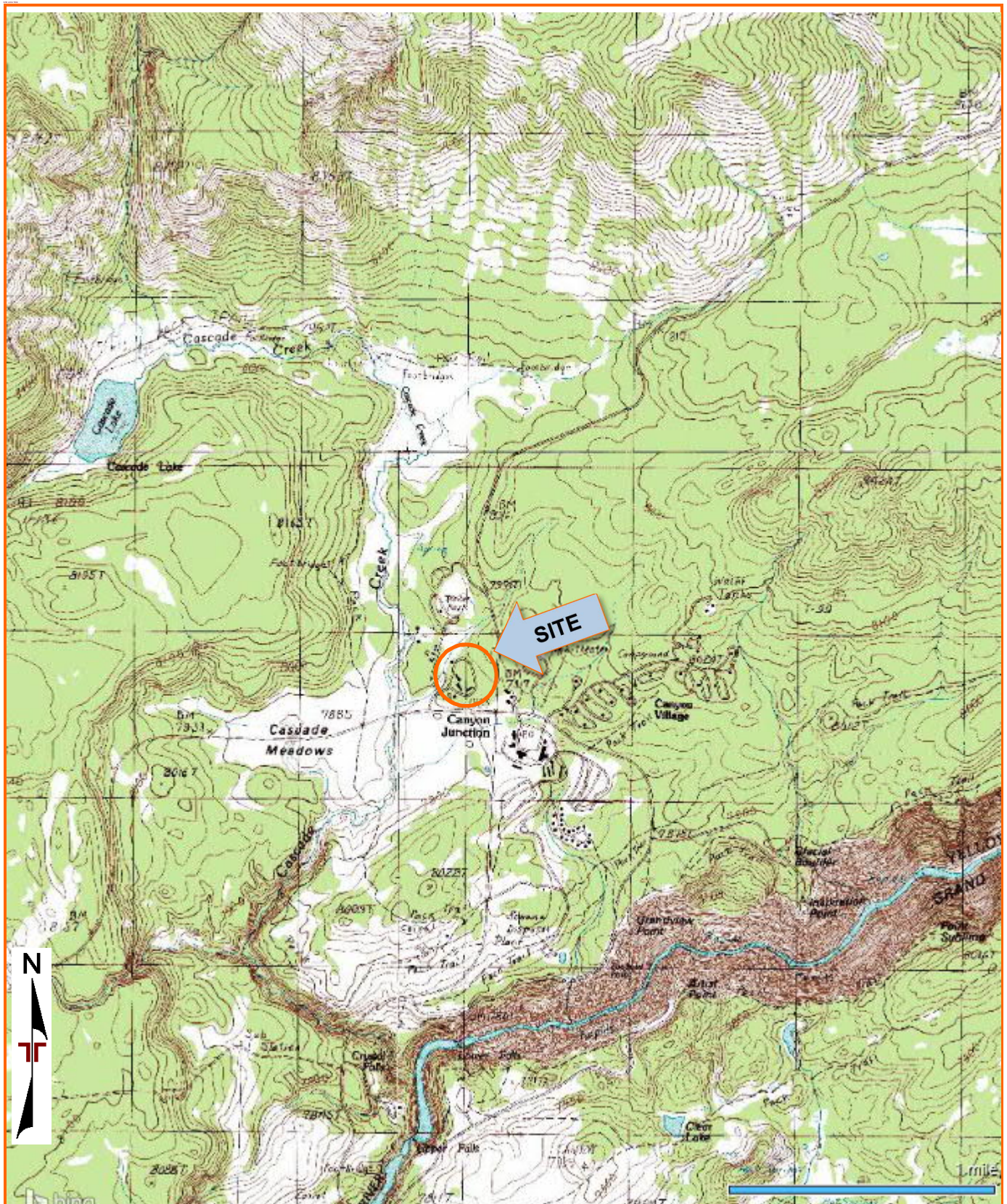


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

MAP PROVIDED BY MICROSOFT BING MAPS

EXPLORATION PLAN

Canyon Housing Upgrades, YELL 309913 Predesign Services
Yellowstone National Park, WY
November 23, 2020 ■ Terracon Project No. C4205059

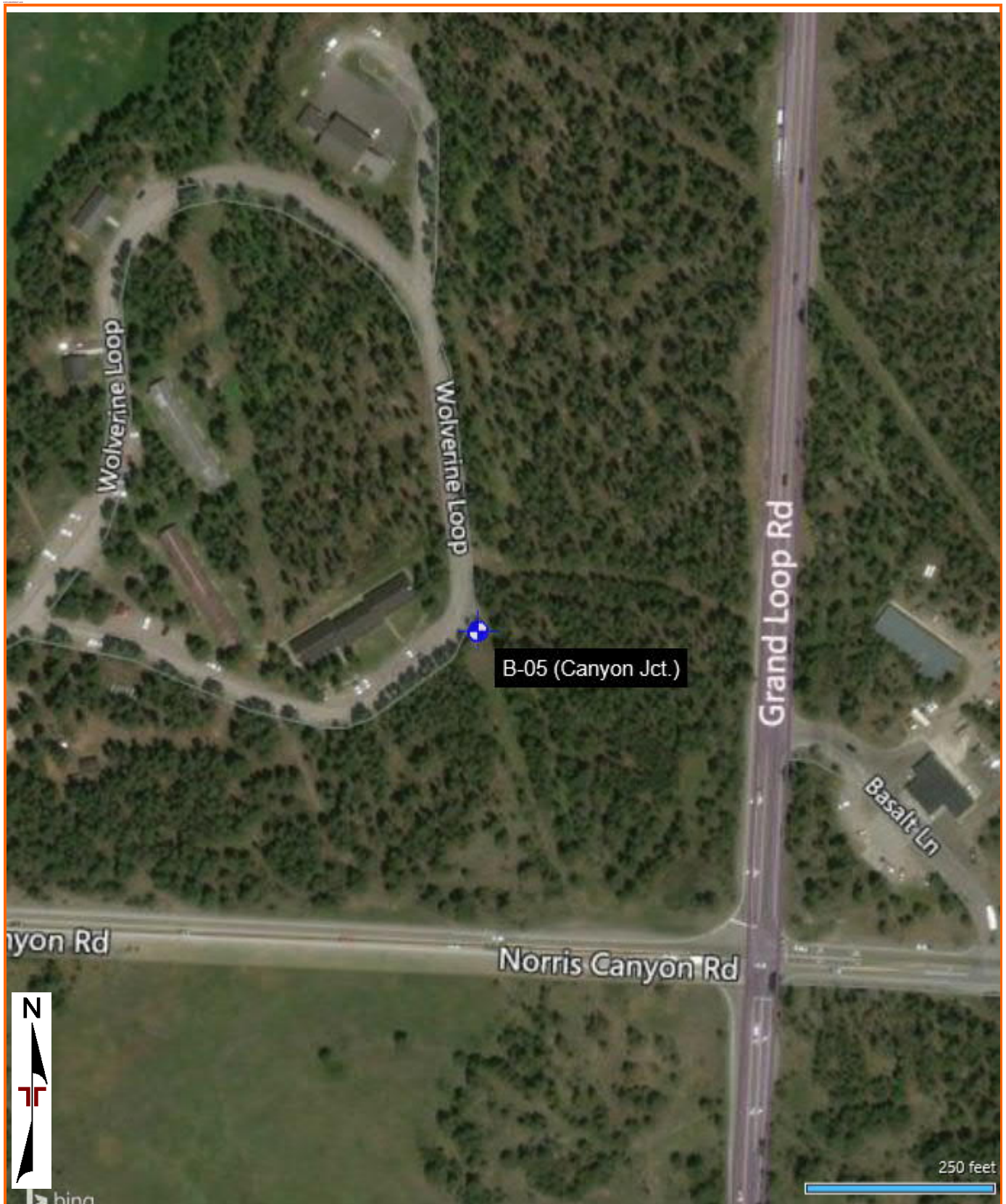


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

MAP PROVIDED BY MICROSOFT BING MAPS

EXPLORATION RESULTS

Contents:

Boring Log (B-05)

Atterberg Limits

Grain Size Distribution

Minimum Laboratory Soil Resistivity

Energy Laboratories Analytical Summary Report

Note: All attachments are one page unless noted above.

BORING LOG NO. B-05 (Canyon Jct.)

Page 1 of 1

PROJECT: Yellowstone National Park (YELL 309913) - 8 Sites Predesign Phase Geotechnical

CLIENT: DJ&A, PC
Missoula, MT

SITE: Canyon Housing Facility
Yellowstone National Park, WY

GRAPHIC LOG	LOCATION See Exploration Plan		DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS	
	Latitude: 44.7372° Longitude: -110.4947°								LL-PL-PI	
	Surface Elev.: 7907.9 (Ft.)									
	ELEVATION (Ft.)									
	DEPTH									
	0.4 TOPSOIL , about 5 inches thick		7907.5			4-10-13 N=23	5.5			
	SILTY SAND (SM) , light brown, medium dense, trace roots/organics, small scattered obsidian fragments									
						5-6-6 N=12	3.6		NP	
	brown, very dense, trace gravels/cobbles, some scattered obsidian fragments		5			12-14-38-50/5"	7.8			
						50/5"	13.8		NP	
	9.0 BEDROCK , hard, severely to completely weathered, poorly cemented, auger refusal, sss bouncing		7899			50/1"	6.8			
	at 9.1 Feet		7899							

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic
Logged by A. Proud

Advancement Method:
3-1/4 inch hollowstem auger

See [Exploration and Testing Procedures](#) for a description of field and laboratory procedures used and additional data (if any).

Notes:

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

See [Supporting Information](#) for explanation of symbols and abbreviations.

Elevations were provided by DJ&A Surveying.

WATER LEVEL OBSERVATIONS

Groundwater not encountered

Terracon

1392 13th Ave SW
Great Falls, MT

Boring Started: 10-19-2020

Boring Completed: 10-19-2020

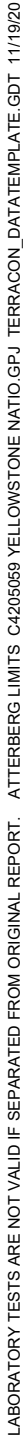
Drill Rig: B59 Foremost Mobile

Driller: C. Tigart

Project No.: C4205059

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL C4205059 YELLOWSTONE NATIO.GPJ TERRACON_DATATEMPLATE.GDT 11/18/20

ASTM D4318

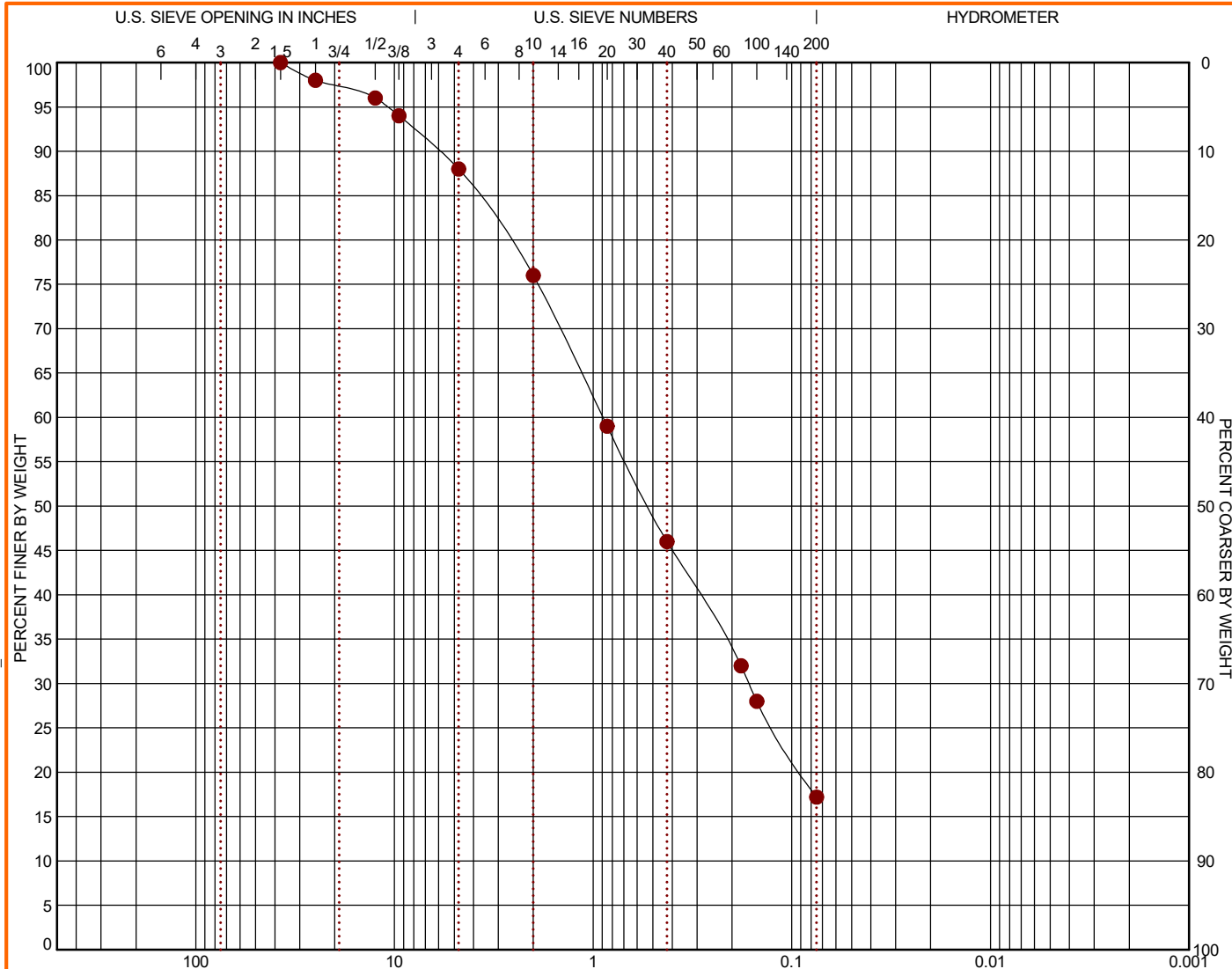


CLIENT: DJ&A, PC
Missoula, MT

GRAIN SIZE DISTRIBUTION

ASTM D422 / ASTM C136

LABORATORY TESTS ARE NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GRAIN SIZE: USCS 1 C4205059 YELLOWSTONE NATIO.GPJ TERRACON_DATATEMPLATE.GDT 11/19/20



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

BORING ID	DEPTH	% COBBLES	% GRAVEL	% SAND	% SILT	% FINES	% CLAY	USCS
● B-05	6	0.0	12.0	70.8		17.2		

GRAIN SIZE				SOIL DESCRIPTION			
	●			Sieve	% Finer	Sieve	% Finer
D ₆₀	0.894			1 1/2"	100.0		
D ₃₀	0.164			1"	98.0		
D ₁₀				1/2"	96.0		
				3/8"	94.0		
				#4	88.0		
				#10	76.0		
				#20	59.0		
				#40	46.0		
				#80	32.0		
				#100	28.0		
				#200	17.2		
COEFFICIENTS				REMARKS			
	●			●	Silty Sand (SM)		
C _c							
C _u							

PROJECT: Yellowstone National Park (YELL 309913) - 8 Sites Predesign Phase
Geotechnical

SITE: Canyon Housing Facility
Yellowstone National Park, WY

Terracon

1392 13th Ave SW
Great Falls, MT

PROJECT NUMBER: C4205059

CLIENT: DJ&A, PC
Missoula, MT



Minimum Soil Resistivity

AASHTO T288-92 (1996)

1392 13th Ave SW, Great Falls, Montana 59404

(406) 453-5400

Project: Canyon Housing Upgrades, YELL 309913 Predesign Services
Job No: C4205059 Report No.: C4205059

Date: 11/4/2020
Sample No.: Split Spoon

Drill Hole: B-05 Depth: 2.5' - 4.0'
Classification: Silty Sand (SM)
Material Size: -#10

Tested By: AP
Reviewed By: MDH

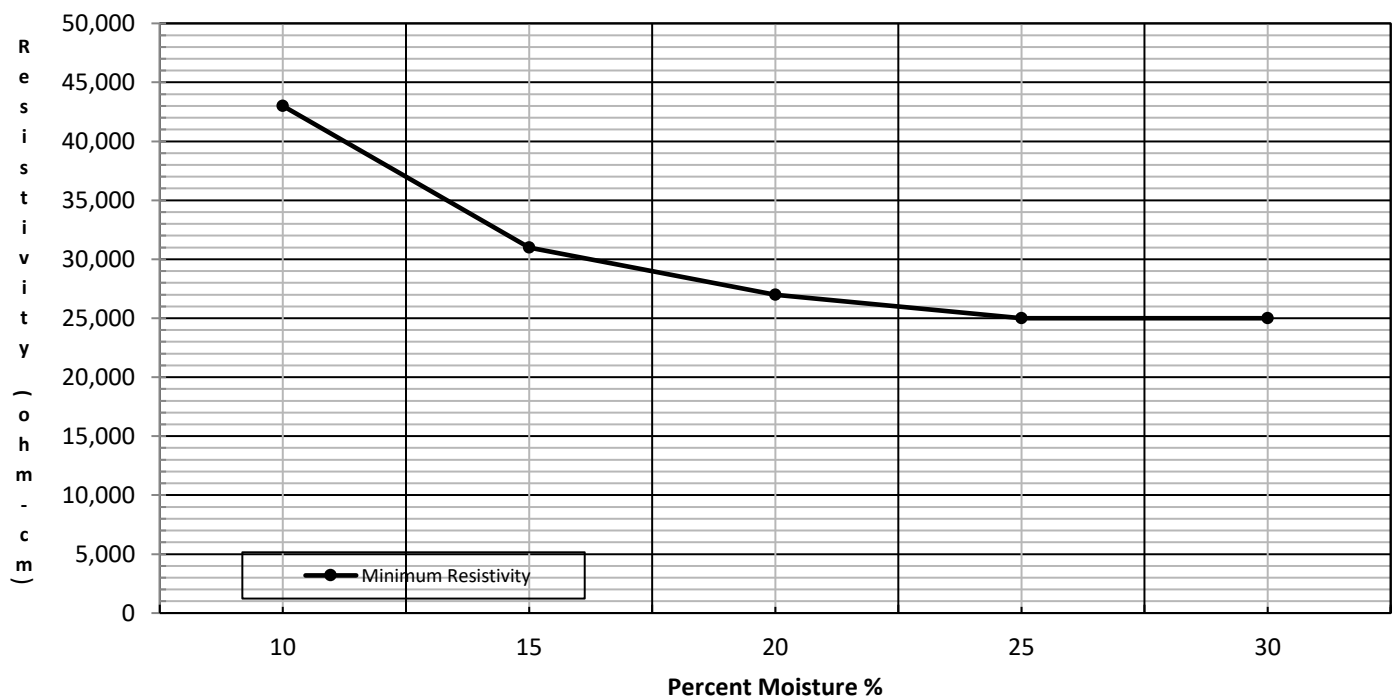
Remarks: pH = 7.1, Sulfate Content = .0013% as tested by Energy Laboratories in Helena, MT

Soil Data (As Received)

wet (g):	na	Weight of Sample (g):	200	Initial Moisture %:	10
dry (g):	na	As Received MC%:	na	5% Increments (g):	10
pan (g):	na	Beginning MC%:	10	Resistivity (ohm-cm):	25,000

% Moisture Added	Reading	Box Constant	Multilplier	Resistivity (ohm-cm)
10	4.3	10	1000	43,000
15	3.1	10	1000	31,000
20	2.7	10	1000	27,000
25	2.5	10	1000	25,000
30	2.5	10	1000	25,000

Minimum Resistivity





ANALYTICAL SUMMARY REPORT

November 18, 2020

Terracon Consultants
1392 13th Ave S W
Great Falls, MT 59404-3155

Work Order: H20110098

Project Name: Yellowstone National Park (YNP)

Energy Laboratories Inc Helena MT received the following 8 samples for Terracon Consultants on 11/4/2020 for analysis.

Lab ID	Client Sample ID	Collect Date	Receive Date	Matrix	Test
H20110098-001	YNP, B2; 5-7'	11/03/20 13:00	11/04/20	Soil	Anions, Water Extractable pH, 1:X Water Extractable DI Water Soil Extract ASA10-3 Soil Preparation USDA1
H20110098-002	YNP, B4; 5-7'	11/03/20 13:00	11/04/20	Soil	Anions, Water Extractable pH, 1:X Water Extractable DI Water Soil Extract ASA10-3
H20110098-003	YNP, B5; 2.5-4'	11/03/20 13:00	11/04/20	Soil	Same As Above
H20110098-004	YNP, B6; 5-7'	11/03/20 13:00	11/04/20	Soil	Same As Above
H20110098-005	YNP, B9; 5-7'	11/03/20 13:00	11/04/20	Soil	Same As Above
H20110098-006	YNP, B10; 5-6.5'	11/03/20 13:00	11/04/20	Soil	Same As Above
H20110098-007	YNP, B11; 5-7'	11/03/20 13:00	11/04/20	Soil	Same As Above
H20110098-008	YNP, B12; 5-7'	11/03/20 13:00	11/04/20	Soil	Same As Above

The analyses presented in this report were performed by Energy Laboratories, Inc., 3161 E. Lyndale Ave., Helena, MT 59604, unless otherwise noted. Any exceptions or problems with the analyses are noted in the Laboratory Analytical Report, the QA/QC Summary Report, or the Case Narrative. Any issues encountered during sample receipt are documented in the Work Order Receipt Checklist.

The results as reported relate only to the item(s) submitted for testing. This report shall be used or copied only in its entirety. Energy Laboratories, Inc. is not responsible for the consequences arising from the use of a partial report.

If you have any questions regarding these test results, please contact your Project Manager.

Report Approved By:


Project Manager - Helena, MT

Digitally signed by
Wanda Johnson
Date: 2020.11.18 13:07:29 -07:00



CLIENT: Terracon Consultants
Project: Yellowstone National Park (YNP)
Work Order: H20110098

Revised Date: 11/18/20

Report Date: 11/18/20

CASE NARRATIVE

Revised Report due to the project name was incorrect. No data has changed. wj 11/18/2020



LABORATORY ANALYTICAL REPORT

Prepared by Helena, MT Branch

Client: Terracon Consultants
Project: Yellowstone National Park (YNP)
Lab ID: H20110098-001
Client Sample ID: YNP, B2; 5-7'

Revised Date: 11/18/20
Report Date: 11/18/20
Collection Date: 11/03/20 13:00
Date Received: 11/04/20
Matrix: Soil

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
1:X SOIL:WATER							
pH, 1:2	7.8	s.u.		0.1		ASA10-3	11/08/20 10:55 / sah
WATER EXTRACTABLE							
Sulfate, 1:2	3	mg/kg		1		E300.0	11/12/20 02:00 / RAT

Report
Definitions: RL - Analyte Reporting Limit
QCL - Quality Control Limit

MCL - Maximum Contaminant Level
ND - Not detected at the Reporting Limit (RL)



LABORATORY ANALYTICAL REPORT

Prepared by Helena, MT Branch

Client: Terracon Consultants
Project: Yellowstone National Park (YNP)
Lab ID: H20110098-002
Client Sample ID: YNP, B4; 5-7'

Revised Date: 11/18/20
Report Date: 11/18/20
Collection Date: 11/03/20 13:00
Date Received: 11/04/20
Matrix: Soil

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
1:X SOIL:WATER							
pH, 1:2	7.4	s.u.		0.1		ASA10-3	11/08/20 10:58 / sah
WATER EXTRACTABLE							
Sulfate, 1:2	4	mg/kg		1		E300.0	11/12/20 02:14 / RAT

Report
Definitions: RL - Analyte Reporting Limit
QCL - Quality Control Limit

MCL - Maximum Contaminant Level
ND - Not detected at the Reporting Limit (RL)



LABORATORY ANALYTICAL REPORT

Prepared by Helena, MT Branch

Client: Terracon Consultants
Project: Yellowstone National Park (YNP)
Lab ID: H20110098-003
Client Sample ID: YNP, B5; 2.5-4'

Revised Date: 11/18/20
Report Date: 11/18/20
Collection Date: 11/03/20 13:00
Date Received: 11/04/20
Matrix: Soil

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
1:X SOIL:WATER							
pH, 1:2	7.1	s.u.		0.1		ASA10-3	11/08/20 11:01 / sah
WATER EXTRACTABLE							
Sulfate, 1:2	13	mg/kg		1		E300.0	11/12/20 03:26 / RAT

Report
Definitions: RL - Analyte Reporting Limit
QCL - Quality Control Limit

MCL - Maximum Contaminant Level
ND - Not detected at the Reporting Limit (RL)



LABORATORY ANALYTICAL REPORT

Prepared by Helena, MT Branch

Client: Terracon Consultants
Project: Yellowstone National Park (YNP)
Lab ID: H20110098-004
Client Sample ID: YNP, B6; 5-7'

Revised Date: 11/18/20
Report Date: 11/18/20
Collection Date: 11/03/20 13:00
Date Received: 11/04/20
Matrix: Soil

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
1:X SOIL:WATER							
pH, 1:2	7.8	s.u.		0.1		ASA10-3	11/08/20 11:03 / sah
WATER EXTRACTABLE							
Sulfate, 1:2	23	mg/kg		1		E300.0	11/12/20 03:41 / RAT

Report
Definitions: RL - Analyte Reporting Limit
QCL - Quality Control Limit

MCL - Maximum Contaminant Level
ND - Not detected at the Reporting Limit (RL)



LABORATORY ANALYTICAL REPORT

Prepared by Helena, MT Branch

Client: Terracon Consultants
Project: Yellowstone National Park (YNP)
Lab ID: H20110098-005
Client Sample ID: YNP, B9; 5-7'

Revised Date: 11/18/20
Report Date: 11/18/20
Collection Date: 11/03/20 13:00
Date Received: 11/04/20
Matrix: Soil

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
1:X SOIL:WATER							
pH, 1:2	7.6	s.u.		0.1		ASA10-3	11/08/20 11:05 / sah
WATER EXTRACTABLE							
Sulfate, 1:2	6	mg/kg		1		E300.0	11/12/20 03:55 / RAT

Report
Definitions: RL - Analyte Reporting Limit
QCL - Quality Control Limit

MCL - Maximum Contaminant Level
ND - Not detected at the Reporting Limit (RL)



LABORATORY ANALYTICAL REPORT

Prepared by Helena, MT Branch

Client: Terracon Consultants
Project: Yellowstone National Park (YNP)
Lab ID: H20110098-006
Client Sample ID: YNP, B10; 5-6.5'

Revised Date: 11/18/20
Report Date: 11/18/20
Collection Date: 11/03/20 13:00
Date Received: 11/04/20
Matrix: Soil

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
1:X SOIL:WATER							
pH, 1:2	7.6	s.u.		0.1		ASA10-3	11/08/20 11:08 / sah
WATER EXTRACTABLE							
Sulfate, 1:2	9	mg/kg		1		E300.0	11/12/20 04:09 / RAT

Report
Definitions: RL - Analyte Reporting Limit
QCL - Quality Control Limit

MCL - Maximum Contaminant Level
ND - Not detected at the Reporting Limit (RL)



LABORATORY ANALYTICAL REPORT

Prepared by Helena, MT Branch

Client: Terracon Consultants
Project: Yellowstone National Park (YNP)
Lab ID: H20110098-007
Client Sample ID: YNP, B11; 5-7'

Revised Date: 11/18/20
Report Date: 11/18/20
Collection Date: 11/03/20 13:00
Date Received: 11/04/20
Matrix: Soil

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
1:X SOIL:WATER							
pH, 1:2	5.7	s.u.		0.1		ASA10-3	11/08/20 11:09 / sah
WATER EXTRACTABLE							
Sulfate, 1:2	40	mg/kg		1		E300.0	11/12/20 04:24 / RAT

Report
Definitions: RL - Analyte Reporting Limit
QCL - Quality Control Limit

MCL - Maximum Contaminant Level
ND - Not detected at the Reporting Limit (RL)



LABORATORY ANALYTICAL REPORT

Prepared by Helena, MT Branch

Client: Terracon Consultants
Project: Yellowstone National Park (YNP)
Lab ID: H20110098-008
Client Sample ID: YNP, B12; 5-7'

Revised Date: 11/18/20
Report Date: 11/18/20
Collection Date: 11/03/20 13:00
Date Received: 11/04/20
Matrix: Soil

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
1:X SOIL:WATER							
pH, 1:2	8.2	s.u.		0.1		ASA10-3	11/08/20 11:11 / sah
WATER EXTRACTABLE							
Sulfate, 1:2	19	mg/kg		1		E300.0	11/12/20 04:38 / RAT

Report
Definitions: RL - Analyte Reporting Limit
QCL - Quality Control Limit

MCL - Maximum Contaminant Level
ND - Not detected at the Reporting Limit (RL)



QA/QC Summary Report

Prepared by Helena, MT Branch

Revised Date: 11/18/20

Client: Terracon Consultants

Work Order: H20110098

Report Date: 11/18/20

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: ASA10-3										al Run: SOIL PH METER - ORION A211_201108A
Lab ID: ICV_1_201108_1										11/08/20 10:47
pH, 1:2		10.0	s.u.	0.10	100	99	101			
Lab ID: CCV_1_201108_1										11/08/20 10:50
pH, 1:2		6.99	s.u.	0.10	100	98.6	101.4			
Lab ID: CCV1_1_201108_1										11/08/20 10:51
pH, 1:2		4.00	s.u.	0.10	100	97.5	102.5			
Lab ID: CCV_3_201108_1										11/08/20 11:13
pH, 1:2		7.00	s.u.	0.10	100	98.6	101.4			

Qualifiers:

RL - Analyte Reporting Limit

ND - Not detected at the Reporting Limit (RL)



QA/QC Summary Report

Prepared by Helena, MT Branch

Revised Date: 11/18/20

Client: Terracon Consultants

Work Order: H20110098

Report Date: 11/18/20

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method:	E300.0	Analytical Run: IC METROHM_201110B								
Lab ID:	ICV	Initial Calibration Verification Standard								11/11/20 02:07
Sulfate		398	mg/L	1.0	100	90	110			
Lab ID:	CCV	Continuing Calibration Verification Standard								11/11/20 02:50
Sulfate		207	mg/L	1.0	104	90	110			
Lab ID:	CCB	Continuing Calibration Blank								11/11/20 03:19
Sulfate		0.0290	mg/L	1.0						
Method:	E300.0									Batch: 54116
Lab ID:	MB-54116	Method Blank				Run: IC METROHM_201110B			11/12/20 01:31	
Sulfate, 1:2		0.2	mg/kg	0.08						
Lab ID:	LCS-54116	Laboratory Control Sample				Run: IC METROHM_201110B			11/12/20 01:46	
Sulfate, 1:2		666	mg/kg	1.0	112	70	130			
Lab ID:	H20110098-002ADUP	Sample Duplicate				Run: IC METROHM_201110B			11/12/20 02:29	
Sulfate, 1:2		4.27	mg/kg	1.0				9.1	20	
Lab ID:	H20110098-008AMS	Sample Matrix Spike				Run: IC METROHM_201110B			11/12/20 04:53	
Sulfate, 1:2		999	mg/kg	1.1	98	90	110			

Qualifiers:

RL - Analyte Reporting Limit

ND - Not detected at the Reporting Limit (RL)



Work Order Receipt Checklist

Terracon Consultants

H20110098

Login completed by: Elizabeth E. Hodgson

Date Received: 11/4/2020

Reviewed by: BL2000\sdull

Received by: kjk

Reviewed Date: 11/8/2020

Carrier name: FedEx Ground

Shipping container/cooler in good condition?	Yes ☒	No ☐	Not Present ☐
Custody seals intact on all shipping container(s)/cooler(s)?	Yes ☐	No ☐	Not Present ☒
Custody seals intact on all sample bottles?	Yes ☐	No ☐	Not Present ☒
Chain of custody present?	Yes ☒	No ☐	
Chain of custody signed when relinquished and received?	Yes ☒	No ☐	
Chain of custody agrees with sample labels?	Yes ☐	No ☒	
Samples in proper container/bottle?	Yes ☒	No ☐	
Sample containers intact?	Yes ☒	No ☐	
Sufficient sample volume for indicated test?	Yes ☒	No ☐	
All samples received within holding time? (Exclude analyses that are considered field parameters such as pH, DO, Res Cl, Sulfite, Ferrous Iron, etc.)	Yes ☒	No ☐	
Temp Blank received in all shipping container(s)/cooler(s)?	Yes ☐	No ☒	Not Applicable ☐
Container/Temp Blank temperature:	19.7°C No Ice		
Water - VOA vials have zero headspace?	Yes ☐	No ☐	No VOA vials submitted ☒
Water - pH acceptable upon receipt?	Yes ☐	No ☐	Not Applicable ☒

Standard Reporting Procedures:

Lab measurement of analytes considered field parameters that require analysis within 15 minutes of sampling such as pH, Dissolved Oxygen and Residual Chlorine, are qualified as being analyzed outside of recommended holding time.

Solid/soil samples are reported on a wet weight basis (as received) unless specifically indicated. If moisture corrected, data units are typically noted as –dry. For agricultural and mining soil parameters/characteristics, all samples are dried and ground prior to sample analysis.

Radiochemical precision results represent a 2-sigma Total Measurement Uncertainty.

Contact and Corrective Action Comments:

No time on the COC when the client relinquished the COC. No time or date on sample containers. No time on COC so estimated in lab. Punctuation inconsistent on samples. EH 11/4/2020

Chain Of Custody and Analytical Request Record

Page 1 of 2

f 14

Company Name: Terracon		Project Name, PWS #, Permit #, Etc. Yellowstone National Park (YNP)	
Report Mail Address: 1392 13th Ave SW Great Falls, MT 59404		Contact Name, Phone, Fax, E-mail: Adam Proud 406-788-7632 adam.proud@terracon.com	
Invoice Address: same as above		Invoice Contact and Phone #: Jessica Wharton, 406-453-5400	
Purchase Order #:		ELI Quote #:	
Report Required For: POTW/WWT ☐ DW ☐ Other _____		Notify ELI prior to RUSH sample submital for additional charges and scheduling	
Special Report Formats - ELI must be notified prior to sample submital for the following: NELAC ☐ A2LA ☐ Level IV ☐ Other _____ EDD/EDT ☐ Formal _____		Comments:	
SAMPLE IDENTIFICATION (Name, Location, Interval, etc.)		ANALYSIS REQUESTED	
1 YNP, B2, 5-7'		Number of Containers Sample Type: A W S V B O Air Water Soils/Solids Vegetation Bioassay Other	
2 YNP, B4, 5-7'		pH	
3 YNP, B5, 2.5-4'		Sulfate	
4 YNP, B6, 5-7'		SEE ATTACHED	
5 YNP, B9, 5-7'		Normal Turnaround (TAT)	
6 YNP, B10, 5-6.5'		RUSH Turnaround (TAT)	
7 YNP, B11, 5-7'		H20110098	
8 YNP, B12, 5-7'			
9			
10			
Relinquished by (print): Adam Proud		Signature: Adam Proud	
Relinquished by (print):		Signature:	
Date/Time: 11-3-2020		Date/Time: 11-3-2020	
Lab Disposal: X		Received by (print): Kevin Kent	
Sample Disposal: Return to client: _____		Date/Time: 11-4-20 1221	
Custody Record MUST be Signed		LABORATORY USE ONLY	
Signature: [Signature]		Signature: [Signature]	

In certain circumstances, samples submitted to Energy Laboratories, Inc. may be subcontracted to other certified laboratories in order to complete the analysis requested. This serves as notice of this possibility. All subcontracted data will be clearly annotated on your analytical report.

Visit our website at www.energylab.com for additional information, downloadable fee schedule, forms, & links.

SUPPORTING INFORMATION

Contents:

General Notes

Unified Soil Classification System

Note: All attachments are one page unless noted above.

GENERAL NOTES

DESCRIPTION OF SYMBOLS AND ABBREVIATIONS

Yellowstone National Park (YELL 309913) - 8 Sites Predesign Phase Geotechnical

Yellowstone National Park, WY ■ Terracon Project No. C4205059

SAMPLING	WATER LEVEL	FIELD TESTS
 Ring Sampler  Split Spoon	 Water Initially Encountered  Water Level After a Specified Period of Time  Water Level After a Specified Period of Time  Cave In Encountered Water levels indicated on the soil boring logs are the levels measured in the borehole at the times indicated. Groundwater level variations will occur over time. In low permeability soils, accurate determination of groundwater levels is not possible with short term water level observations.	N Standard Penetration Test Resistance (Blows/Ft.) (HP) Hand Penetrometer (T) Torvane (DCP) Dynamic Cone Penetrometer UC Unconfined Compressive Strength (PID) Photo-Ionization Detector (OVA) Organic Vapor Analyzer

DESCRIPTIVE SOIL CLASSIFICATION

Soil classification as noted on the soil boring logs is based Unified Soil Classification System. Where sufficient laboratory data exist to classify the soils consistent with ASTM D2487 "Classification of Soils for Engineering Purposes" this procedure is used. ASTM D2488 "Description and Identification of Soils (Visual-Manual Procedure)" is also used to classify the soils, particularly where insufficient laboratory data exist to classify the soils in accordance with ASTM D2487. In addition to USCS classification, coarse grained soils are classified on the basis of their in-place relative density, and fine-grained soils are classified on the basis of their consistency. See "Strength Terms" table below for details. The ASTM standards noted above are for reference to methodology in general. In some cases, variations to methods are applied as a result of local practice or professional judgment.

LOCATION AND ELEVATION NOTES

Exploration point locations as shown on the Exploration Plan and as noted on the soil boring logs in the form of Latitude and Longitude are approximate. See [Exploration and Testing Procedures](#) in the report for the methods used to locate the exploration points for this project. Surface elevation data annotated with +/- indicates that no actual topographical survey was conducted to confirm the surface elevation. Instead, the surface elevation was approximately determined from topographic maps of the area.

STRENGTH TERMS

RELATIVE DENSITY OF COARSE-GRAINED SOILS (More than 50% retained on No. 200 sieve.) Density determined by Standard Penetration Resistance			CONSISTENCY OF FINE-GRAINED SOILS (50% or more passing the No. 200 sieve.) Consistency determined by laboratory shear strength testing, field visual-manual procedures or standard penetration resistance			
Descriptive Term (Density)	Standard Penetration or N-Value Blows/Ft.	Ring Sampler Blows/Ft.	Descriptive Term (Consistency)	Unconfined Compressive Strength Qu, (psf)	Standard Penetration or N-Value Blows/Ft.	Ring Sampler Blows/Ft.
Very Loose	0 - 3	0 - 6	Very Soft	less than 500	0 - 1	< 3
Loose	4 - 9	7 - 18	Soft	500 to 1,000	2 - 4	3 - 4
Medium Dense	10 - 29	19 - 58	Medium Stiff	1,000 to 2,000	4 - 8	5 - 9
Dense	30 - 50	59 - 98	Stiff	2,000 to 4,000	8 - 15	10 - 18
Very Dense	> 50	> 99	Very Stiff	4,000 to 8,000	15 - 30	19 - 42
			Hard	> 8,000	> 30	> 42

RELEVANCE OF SOIL BORING LOG

The soil boring logs contained within this document are intended for application to the project as described in this document. Use of these soil boring logs for any other purpose may not be appropriate.

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests ^A					Soil Classification	
					Group Symbol	Group Name ^B
Coarse-Grained Soils: More than 50% retained on No. 200 sieve	Gravels: More than 50% of coarse fraction retained on No. 4 sieve	Clean Gravels: Less than 5% fines ^C	$Cu \geq 4$ and $1 \leq Cc \leq 3$ ^E	GW	Well-graded gravel ^F	
			$Cu < 4$ and/or $[Cc < 1$ or $Cc > 3.0]$ ^E	GP	Poorly graded gravel ^F	
		Gravels with Fines: More than 12% fines ^C	Fines classify as ML or MH	GM	Silty gravel ^{F, G, H}	
			Fines classify as CL or CH	GC	Clayey gravel ^{F, G, H}	
	Sands: 50% or more of coarse fraction passes No. 4 sieve	Clean Sands: Less than 5% fines ^D	$Cu \geq 6$ and $1 \leq Cc \leq 3$ ^E	SW	Well-graded sand ^I	
			$Cu < 6$ and/or $[Cc < 1$ or $Cc > 3.0]$ ^E	SP	Poorly graded sand ^I	
		Sands with Fines: More than 12% fines ^D	Fines classify as ML or MH	SM	Silty sand ^{G, H, I}	
			Fines classify as CL or CH	SC	Clayey sand ^{G, H, I}	
Fine-Grained Soils: 50% or more passes the No. 200 sieve	Silts and Clays: Liquid limit less than 50	Inorganic:	$PI > 7$ and plots on or above “A”	CL	Lean clay ^{K, L, M}	
			$PI < 4$ or plots below “A” line ^J	ML	Silt ^{K, L, M}	
		Organic:	Liquid limit - oven dried	< 0.75	OL	Organic clay ^{K, L, M, N}
			Liquid limit - not dried			Organic silt ^{K, L, M, O}
	Silts and Clays: Liquid limit 50 or more	Inorganic:	PI plots on or above “A” line	CH	Fat clay ^{K, L, M}	
			PI plots below “A” line	MH	Elastic Silt ^{K, L, M}	
		Organic:	Liquid limit - oven dried	< 0.75	OH	Organic clay ^{K, L, M, P}
			Liquid limit - not dried			Organic silt ^{K, L, M, Q}
Highly organic soils:	Primarily organic matter, dark in color, and organic odor			PT	Peat	

^A Based on the material passing the 3-inch (75-mm) sieve.

^B If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.

^C Gravels with 5 to 12% fines require dual symbols: GW-GM well-graded gravel with silt, GW-GC well-graded gravel with clay, GP-GM poorly graded gravel with silt, GP-GC poorly graded gravel with clay.

^D Sands with 5 to 12% fines require dual symbols: SW-SM well-graded sand with silt, SW-SC well-graded sand with clay, SP-SM poorly graded sand with silt, SP-SC poorly graded sand with clay.

$$E \quad Cu = D_{60}/D_{10} \quad Cc = \frac{(D_{30})^2}{D_{10} \times D_{60}}$$

^F If soil contains $\geq 15\%$ sand, add "with sand" to group name.

^G If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.

^H If fines are organic, add "with organic fines" to group name.

^I If soil contains $\geq 15\%$ gravel, add "with gravel" to group name.

^J If Atterberg limits plot in shaded area, soil is a CL-ML, silty clay.

^K If soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel," whichever is predominant.

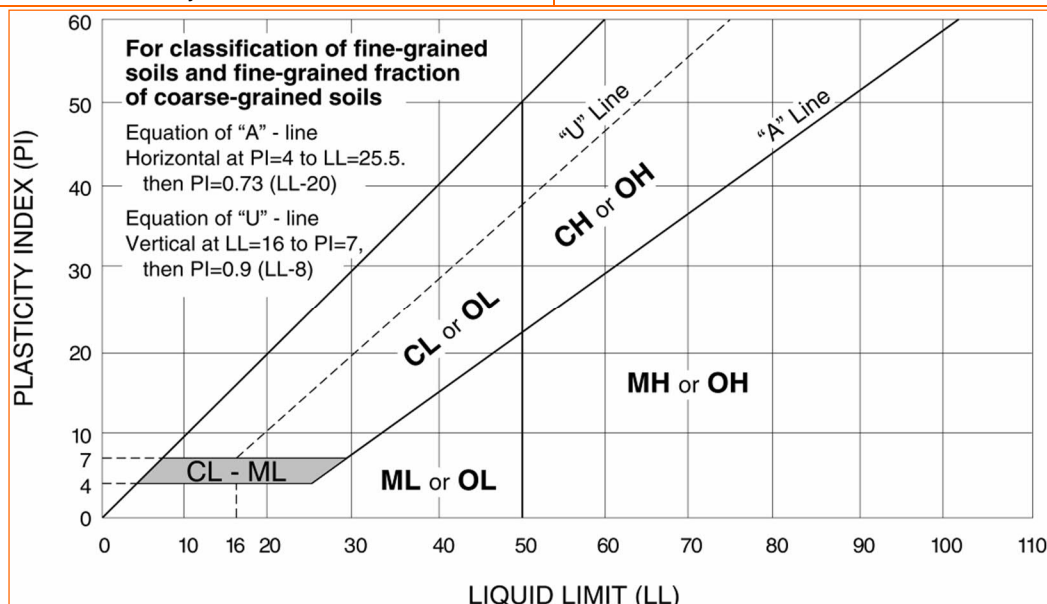
^L If soil contains $\geq 30\%$ plus No. 200 predominantly sand, add "sandy" to group name.

^M If soil contains $\geq 30\%$ plus No. 200, predominantly gravel, add "gravelly" to group name.

^N $PI \geq 4$ and plots on or above "A" line.

^O $PI < 4$ or plots below "A" line.

^P PI plots on or above "A" line.

^Q PI plots below "A" line.


APPENDIX D

Geotechnical Engineering Report Northeast Housing Upgrades



Geotechnical Engineering Report

**Northeast Entrance Housing Upgrades, YELL 309913 Predesign Services
Yellowstone National Park, MT**

November 23, 2020

Terracon Project No. C4205059

Prepared for:

DJ&A, P.C.

2000 Maple Street

Missoula, MT 59808

On behalf of

National Park Service

IMR – Northern Rockies MABO

Prepared by:

Terracon Consultants, Inc.

1392 13 Ave SW

Great Falls, MT 59404



November 23, 2020

DJ&A, P.C.
2000 Maple Street
Missoula, MT 59808



Attn: Mr. Chris Anderson, P.E.
P: (406) 721-4320
E: chris@djanda.com

Re: Geotechnical Engineering Report
Northeast Entrance Housing Upgrades, YELL 309913 Predesign Services
Northeast Entrance Housing Facility on Meridan Road
Yellowstone National Park, MT
Contract No. 140P1220D0002, Task Order No. 140P1421F0001
Terracon Project No. C4205059

Dear Mr. Chris Anderson:

We have completed the Geotechnical Engineering services for the project referenced above. This study was performed in general accordance with Terracon Proposal No. PC4205059 dated October 13, 2020. This report presents the findings of the subsurface exploration and provides geotechnical recommendations concerning earthwork and the design and construction of foundations and floor slabs for the proposed project.

We appreciate the opportunity to be of service to you on this project. If you have any questions concerning this report or if we may be of further service, please contact us.

Sincerely,
Terracon Consultants, Inc.



Matthew D. Hoffmann, P.E.
Office Manager

A handwritten signature in cursive script that reads "Eric D. Bernhardt".

Eric D. Bernhardt, P.E.
Senior Associate

REPORT TOPICS

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Note: This report was originally delivered in a web-based format. **Orange Bold** text in the report indicates a referenced section heading. The PDF version also includes hyperlinks which direct the reader to that section and clicking on the **GeoReport** logo will bring you back to this page. For more interactive features, please view your project online at client.terracon.com.

ATTACHMENTS

EXPLORATION AND TESTING PROCEDURES
PHOTOGRAPHY LOG
SITE LOCATION AND EXPLORATION PLANS
EXPLORATION RESULTS
SUPPORTING INFORMATION

Note: Refer to each individual Attachment for a listing of contents.

Geotechnical Engineering Report
Northeast Entrance Housing Upgrades, YELL 309913 Predesign
Services
Northeast Entrance Housing Facility on Meridan Road
Yellowstone National Park, MT
Terracon Project No. C4205059
November 23, 2020

INTRODUCTION

This report presents the results of our subsurface exploration and geotechnical engineering services performed for the proposed Northeast Entrance Housing Upgrades to be located in Yellowstone National Park, MT at the Northeast Entrance Housing Facility on Meridan Road. The purpose of these services is to provide information and geotechnical engineering recommendations relative to:

- Subsurface soil conditions
- Groundwater conditions
- Site preparation and earthwork
- Frost considerations
- Foundation design and construction
- Floor slab design and construction
- Seismic site classification per IBC
- Lateral earth pressures

The geotechnical engineering Scope of Services for this project included the advancement of a single boring to a depth of approximately 14 feet below existing site grade.

Maps showing the site and boring location are shown in the **Site Location** and **Exploration Plan** sections, respectively. The results of the laboratory testing performed on soil samples obtained from the site during the field exploration are included on the boring log and as separate graphs in the **Exploration Results** section.

SITE CONDITIONS

The following description of site conditions is derived from our site visit in association with the field exploration and our review of publicly available geologic and topographic maps.

Item	Description
Parcel Information	The site is located within the employee housing area on Meridan Road at the Northeast Entrance Facility of Yellowstone National Park, Montana. The project is located north of Northeaset Entrance Road near the Northeast Entrance Gate (Approximate Lat. / Long. : 45.0051° N / 110.0124° W). See Site Location

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Yellowstone National Park, MT

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Item	Description
Existing Improvements	Existing housing units are located to the immediate east of the boring, along with associated site access roads.
Current Ground Cover	Primarily native grasses and gravel surfaced parking areas
Existing Topography	Relatively level, with an approximate Elevation 7406 feet based on DJ&A site survey at the boring location

Geology

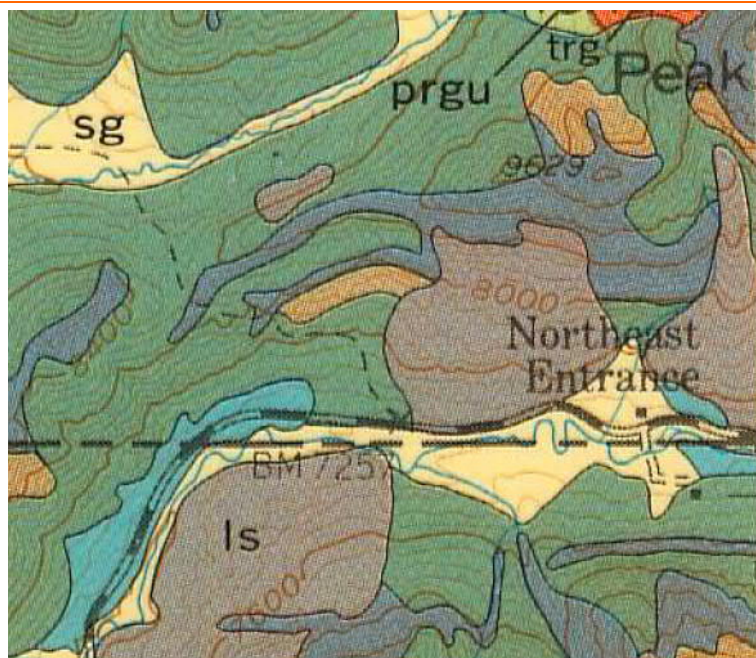


Figure 1: Excerpt from Surficial Geologic Map of Yellowstone National Park (by the US Geological Survey 1972).

The site is situated northwest of the Northeast Entrance within a primarily alluvial sand and gravel deposit (**sg-tan**). The overburden is underlain by bedrock at relatively shallow depths that consists predominantly of Rhyolite flow parent rock.

We also collected photographs at the time of our field exploration program. Representative photos are provided in our [Photography Log](#).

PROJECT DESCRIPTION

Our initial understanding of the project was provided in our proposal, and was consistent with the details provided within the Request for Proposal and Description of Work provided by DJ&A on October 7, 2020, and our final understanding of the project conditions is as follows:

Geotechnical Engineering Report

Northeast Entrance Housing Upgrades, YELL 309913 Predesign Services

Yellowstone National Park, MT

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Item	Description
Information Provided	We were provided with the following documents from DJ&A via e-mail between October 1 and 7, 2020: ■ Request for Qualifications dated October 1, 2020, which included a Description of Work for the Geotechnical Survey and Mapping Survey for Eight Sites within Yellowstone along with site layouts of each proposed site utilizing Google Earth Pro ■ Request for Price Proposal dated October 7, 2020, which included the above documents as well
Project Description	Proposed construction site for new employee housing
Proposed Structures	Size and quantity unknown at this time
Building Construction	Anticipated wood-framed construction utilizing frost-depth, continuous reinforced concrete foundations with potential concrete slab-on-grade floors
Finished Floor Elevation	Not provided at this pre-design phase, and likely to vary
Maximum Loads	Assuming lightly loaded structure with loads on the order of: ■ Walls: 1-3 kips per linear foot (klf) ■ Columns: 25 kips maximum ■ Slabs: 150 pounds per square foot (psf)
Grading/Slopes	Relatively flat

GEOTECHNICAL CHARACTERIZATION

We have developed a general characterization of the subsurface conditions based upon our review of the subsurface exploration, laboratory data, geologic setting and our understanding of the project. This characterization, termed GeoModel, forms the basis of our geotechnical calculations and evaluation of site preparation and foundation recommendations. Conditions encountered at the exploration point are indicated on the boring log. The boring log can be found in the **Exploration Results** section of this report.

As part of our analyses, we identified the following model layers within the subsurface profile. For a more detailed view of the model layer depth at the boring, refer to the boring log.

Model Layer	Layer Name	General Description
1	Fill	Silty sand, brown to dark brown, loose, likely site grade raising materials for existing housing development area and access roads
2	Gravel	Light brown and brown, loose to medium dense, varying amounts of fines and sands, trace oxidation, larger cobbles and boulders

The boring was observed while drilling and immediately after completion for the presence and level of groundwater. Groundwater was not observed in the boring at the time of our exploration. The field investigation does not fully reflect seasonal or long-term groundwater conditions which will be influenced by precipitation, hydrologic impacts originating off-site, and other factors beyond the scope of this investigation. Therefore, groundwater levels during construction or at other times in the life of the structures may vary from the conditions indicated on the Log.

GEOTECHNICAL OVERVIEW

The establishment of effective drainage should be completed early in the construction sequence and maintained throughout and following construction to avoid potential issues with subgrade disturbance or stability. If possible, grading operations should be performed during the warmer and drier times of the year. If grading is performed during the winter months, an increased risk for possible undercutting and replacement of unstable subgrade will persist. Additional site preparation recommendations, including subgrade improvement and fill placement, are provided in the **Earthwork** section.

The clayey gravel soils which form the bearing stratum for shallow foundations are generally low-plasticity, exhibiting low potential for shrink-swell movements with changes in moisture. The **Shallow Foundations** section addresses support of the buildings bearing on properly prepared native sand soils. The **Floor Slabs** section addresses slab-on-grade support of the buildings, if selected to utilization.

The **General Comments** section provides an understanding of the report limitations.

EARTHWORK

Earthwork is anticipated to include clearing and grubbing, excavations, and fill placement. The following sections provide recommendations for use in the preparation of specifications for the work. Recommendations include critical quality criteria, as necessary, to render the site in the state considered in our geotechnical engineering evaluation for foundations and floor slabs.

Site Preparation

Prior to placing fill, existing vegetation, root mat, and existing uncontrolled fill (upper silty sand fill) should be removed. Complete stripping of the topsoil should be performed in the proposed building areas.

Performance of foundations and slabs bearing with the native clayey gravel subgrade will be heavily dependent upon quality earthwork operations and preparation of the bearing surface. Following stripping, foundation excavations should be conducted to base of anticipated footing

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elevation by means of excavation equipment operating from above and outside the limits of the subgrade to limit disturbance to the sand subgrade. Following excavation to footing bearing elevation, the gravel subgrade surface should be scarified, moisture conditioned and compacted to a minimum of 98 percent of the maximum laboratory dry density value (per ASTM D698) to provide for a properly prepared bearing surface to receive foundation concrete. The bearing surface should be observed and tested by our Geotechnical Engineer to ensure that proper preparation to recover any disturbance to the subgrade has been conducted. It will be important to limit the potential for moisture increase to the subgrade following preparation, and concrete placement should be conducted as soon as possible following excavation to and acceptance of the bearing surface subgrade. Areas delineated during this subgrade observation that are not properly prepared, or are inconsistent with the anticipated subgrade conditions, should be corrected as directed by the Geotechnical Engineer. Excessively wet or dry material should either be removed and replaced with Structural Fill, or moisture conditioned and recompacted as directed by the Geotechnical Engineer.

Fill Material Types

Engineered fill required to achieve design grade should be classified as Structural Fill and general fill. Structural Fill is material used below (if needed due to overexcavation of unsuitable materials), or within 5 feet of structures. General fill is material used to achieve grade outside of these areas. Earthen materials used for Structural Fill and general fill should meet the following material property requirements:

Soil Type ¹	USCS Classification	Acceptable Parameters
Structural Fill (imported material)	GW, GP, SW, SP, and dual (GM/SM) symbols	100% passing 1 ½ inch size; 30-60% passing No. 4 screen, and no more than 12% passing No. 200 screen, the fines portion should have a maximum Liquid Limit and Plasticity Index of 25 and 10, respectively.
Crushed Base Course	GW, GP, SW, SP, and dual (GM/SM) symbols	¾ inch minus crushed aggregate base
On-Site Native Soils	GC	The on-site gravel soils appear suitable for use as general fill , including site grade raising material and exterior backfill of foundations.

1. Structural and general fill should consist of approved materials free of organic matter and debris. Frozen material should not be used, and fill should not be placed on a frozen subgrade. A sample of each material type should be submitted to the Geotechnical Engineer for evaluation prior to use on this site.
2. Significant moisture conditioning of the native clay may be necessary to meet compaction requirements; this will require mechanical reduction in clay clod size (i.e. diskings, etc.) to a maximum 1-inch dimension to facilitate moisture conditioning; the necessary moisture adjustment will be difficult during wet/cold seasons.

Fill Compaction Requirements

Structural and general fill should meet the following compaction requirements.

Item	Structural Fill	General Fill
Maximum Lift Thickness	8 inches or less in loose thickness when heavy, self-propelled compaction equipment is used 4 to 6 inches in loose thickness when hand-guided equipment (i.e. jumping jack or plate compactor) is used	Same as Structural fill
Minimum Compaction Requirements ^{1, 2}	98% of max. below foundations 95% of max. above foundations and below floor slabs	92% of max.
Water Content Range ¹	Granular: -3% to +1% of optimum	As required to achieve min. compaction requirements

^{1.} Maximum density and optimum water content as determined by the standard Proctor test (ASTM D 698).
^{2.} If the granular material is a coarse sand or gravel, or of a uniform size, or has a low fines content, compaction comparison using local practices may be more appropriate. It should be noted that ASTM D698 allows for rock-correction of samples with up to 30% Retained on the 3/4" screen, but that this can lead to values not attainable in the field. ASTM allows for use of engineering judgement of field test strips. Local practice also has utilized successfully for control of the former ASTM D698 method of rock-replacement.

Utility Trench Backfill

For low permeability subgrades, utility trenches are a common source of water infiltration and migration. Utility trenches penetrating beneath the buildings should be effectively sealed to restrict water intrusion and flow through the trenches, which could migrate below the building. The trench should provide an effective trench plug that extends at least 5 feet from the face of each of the building exteriors. The plug material should consist of cementitious flowable fill or low permeability clay. The trench plug material should be placed to surround the utility line. If used, the clay trench plug material should be placed and compacted at or above optimum water content range to limit potential for moisture infiltration by creating a lower permeability fill zone within the wetted clay.

Grading and Drainage

All grades must provide effective drainage away from the buildings during and after construction and should be maintained throughout the life of the structures. Water retained next to the buildings can result in soil movements greater than those discussed in this report. Greater movements can result in unacceptable differential floor slab and/or foundation movements, cracked slabs and walls, and roof leaks. Roofs should have gutters/drains with downspouts that discharge beyond the backfill zone, preferably onto splash blocks or other erosion resistant materials, at a distance of at least 10 feet from the buildings.

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Exposed ground should be sloped and maintained at a minimum 5 percent away from the buildings for at least 10 feet beyond the perimeter of the buildings. Locally, flatter grades may be necessary to transition ADA access requirements for flatwork. After building construction and landscaping have been completed, final grades should be verified to document effective drainage has been achieved. Grades around the structures should also be periodically inspected and adjusted, as necessary, as part of the structure's maintenance program. Where paving or flatwork abuts the structures, a maintenance program should be established to effectively seal and maintain joints and prevent surface water infiltration.

Earthwork Construction Considerations

Shallow excavations for the proposed structures are anticipated to be accomplished with conventional construction equipment. Upon completion of filling and grading, care should be taken to maintain the subgrade water content prior to construction of floor slabs. Construction traffic over the completed subgrades should be avoided. The site should also be graded to prevent ponding of surface water on the prepared subgrades or in excavations. Water collecting over or adjacent to construction areas should be removed. If the subgrade freezes, desiccates, saturates, or is disturbed, the affected material should be removed, or the materials should be scarified, moisture conditioned, and recompact prior to floor slab construction.

As a minimum, excavations should be performed in accordance with OSHA 29 CFR, Part 1926, Subpart P, "Excavations" and its appendices, and in accordance with any applicable local, and/or state regulations.

Construction site safety is the sole responsibility of the contractor who controls the means, methods, and sequencing of construction operations. Under no circumstances shall the information provided herein be interpreted to mean Terracon is assuming responsibility for construction site safety, or the contractor's activities; such responsibility shall neither be implied nor inferred.

Construction Observation and Testing

The earthwork efforts should be monitored under the direction of the Geotechnical Engineer. Monitoring should include documentation of foundation subgrade preparation, and subgrade mitigation of areas delineated to require mitigation based on review of foundation and slab subgrade conditions.

Each lift of compacted fill should be tested, evaluated, and reworked, as necessary, until approved by the Geotechnical Engineer prior to placement of additional lifts. Each lift of fill should be tested for density and water content. Based on the planned foundation construction it is recommended that testing frequencies as below be utilized:

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- Minimum of one test per isolated (spread) footing, for each lift
- Minimum one test per 50 linear feet of backfill, per lift of foundation backfill
- Minimum of one test for every 500 square feet of compacted fill in the building slab areas
- Minimum one test per lift off compacted utility trench plug

In areas of foundation excavations, the bearing subgrade should be evaluated under the direction of the Geotechnical Engineer. If unanticipated conditions are encountered, the Geotechnical Engineer should prescribe mitigation options.

In addition to the documentation of the essential parameters necessary for construction, the continuation of the Geotechnical Engineer into the construction phase of the project provides the continuity to maintain the Geotechnical Engineer's evaluation of subsurface conditions, including assessing variations and associated design changes.

SHALLOW FOUNDATIONS

The primary geotechnical considerations for the site are to provide reliable bearing within the native clayey gravel with sand deposit, while limiting the potential for differential settlement of the lightly loaded residential structures. The native gravel, which is the predominant subsurface material encountered within the upper 14 feet of the soil profile, varies from loose to medium dense exhibiting moderate shear strength characteristics based on correlations with Standard Penetration Test (SPT) N-values and limited potential for load induced settlements. With proper preparation of the foundation bearing surface, as described within the **Earthwork** section, reliable bearing support and limited settlement of new foundation can be anticipated at the site.

For our analysis, we utilized the profile encountered at Boring B-12 as the controlling subsurface profile with loose to medium dense clayey gravel with extending from overlying fill zone to approximately 147 feet below existing ground surface. For analysis of bearing capacity, we have utilized Gibbs, Holtz, and Meyerhof (1956) correlation between standard penetration resistance, relative density and phi angle for sands to develop our strength parameters. Based on STP N-value of approximately 11 blows per foot at 5 feet below existing grade, we have utilized a cohesion of 0 psf (non-plastic, granular), and a phi angle of 32 degrees from the correlation. Our settlement analysis has been conducted using Schmertmann and Hartman (1978) using strain influence factors semiempirical analysis methods. Therefore, if the native gravel at the site has been prepared in accordance with the requirements noted in **Earthwork**, the following design parameters are applicable for shallow foundations.

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Design Parameters – Compressive Loads

Item	Description
Maximum Allowable Net Bearing Pressure ^{1, 2}	2,500 psf (continuous, strip footings) 2,500 psf (isolated, spread footings)
Required Bearing Stratum ³	Properly prepared and compacted, native clayey gravel with sand or Structural Fill replacement zone if needed for unsuitable subgrade zones
Minimum Foundation Dimensions	Columns: 36 inches Continuous: 18 inches
Ultimate Passive Resistance ⁴ (equivalent fluid pressures)	400 pcf (native clayey gravel backfill) 500 pcf (Structural Fill backfill)
Ultimate Coefficient of Sliding Friction ⁵	0.40 (native clayey gravel) 0.70 (Structural Fill)
Minimum Embedment below Finished Grade ⁶	Exterior footings: 48 inches Interior footings in heated areas: 24 inches
Estimated Total Settlement from Structural Loads ²	Less than about ¾ inch
Estimated Differential Settlement ^{2, 7}	About ½ of total settlement

1. Assumes proper preparation of bearing surface in accordance with **Site Preparation**. Based on a minimum factor of safety of 3.
2. Values provided are for maximum loads noted in **Project Description**.
3. Unsuitable or soft soils should be over-excavated and replaced per the recommendations presented in the **Earthwork**.
4. Use of passive earth pressures require the sides of the excavation for the spread footing foundation to be nearly vertical and the concrete placed neat against these vertical faces or that the footing forms be removed and compacted structural fill be placed against the vertical footing face. A minimum factor of safety of 2 should be applied to ultimate values.
5. Can be used to compute sliding resistance where foundations are placed on suitable soil/materials. Should be neglected for foundations subject to net uplift conditions.
6. Embedment necessary to minimize the effects of frost and/or seasonal water content variations. For sloping ground, maintain depth below the lowest adjacent exterior grade within 5 horizontal feet of the structure, also application of a minimum factor of safety of 2 should be utilized.
7. Differential settlement and resultant deflection profile are as estimated for given column spacing or a maximum spacing of 50 feet.

Foundation Construction Considerations

As noted in **Earthwork**, the footing excavations should be evaluated under the direction of the Geotechnical Engineer. The base of all foundation excavations should be free of water and loose soil, prior to placing concrete. Concrete should be placed soon after excavating to reduce bearing soil disturbance. Care should be taken to prevent wetting or drying of the bearing materials during

Geotechnical Engineering Report

Northeast Entrance Housing Upgrades, YELL 309913 Predesign Services

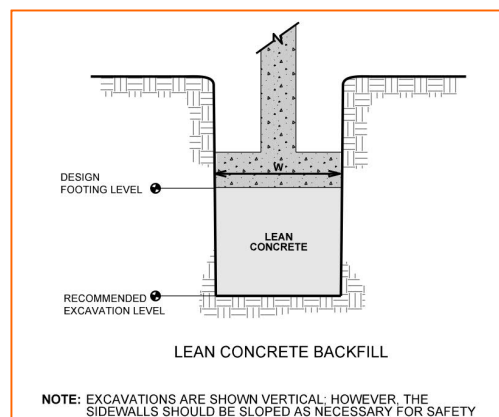
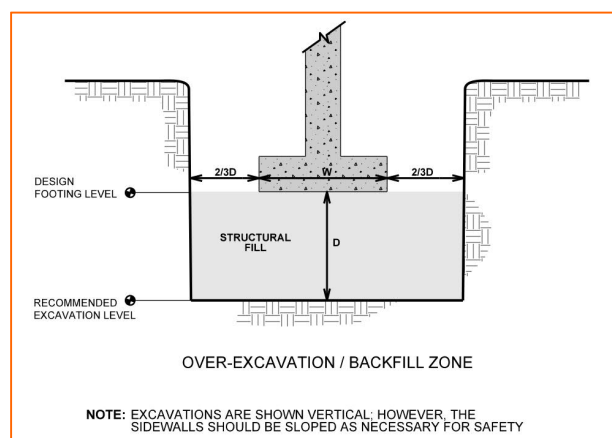
Yellowstone National Park, MT

November 23, 2020 ■ Terracon Project No. C4205059



construction. Excessively wet or dry material or any loose/disturbed material in the bottom of the footing excavations should be removed/reconditioned before foundation concrete is placed.

If unsuitable bearing soils are encountered at the base of the planned footing excavation, the excavation should be extended deeper to suitable soils, and the footings could bear directly on these soils after recovery of any disturbance by compaction at the lower level, replacement Structural Fill compacted as recommended in the **Earthwork** section to base of footing elevation, or on lean concrete backfill placed in the excavations. These methods for replacement are illustrated on the sketches below.



SEISMIC CONSIDERATIONS

The seismic design requirements for buildings and other structures are based on Seismic Design Category. Site Classification is required to determine the Seismic Design Category for a structure. The Site Classification is based on the upper 100 feet of the site profile defined by a weighted average value of either shear wave velocity, standard penetration resistance, or undrained shear strength in accordance with Section 20.4 of ASCE 7 and the International Building Code (IBC).

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Yellowstone National Park, MT

November 23, 2020 ■ Terracon Project No. C4205059



Based on the soil properties encountered at the site and as described on the exploration logs and results, it is our professional opinion that the **Seismic Site Classification is C**. Subsurface explorations at this site were extended to a maximum depth of 21.5 feet. The site properties below the boring depth to 100 feet were estimated based on our experience and knowledge of geologic conditions of the general area. Additional deeper borings or geophysical testing may be performed to confirm the conditions below the current boring depth. A Peak Ground Acceleration (PGA) coefficient of 0.30g is expected for a 2425 year (2% in 50 years) interval based on United States Geological Survey Unified Hazard Tool (<https://earthquake.usgs.gov/hazards/interactive/>).

FLOOR SLABS

Performance of slab-on-grades will be heavily dependent upon quality earthwork operations, and preparation of subgrade as discussed previously in this report. Design parameters for floor slabs assume the requirements for **Earthwork** have been followed, including removal of all fill from below the concrete slabs-on-grade and replacement with Structural Fill. Specific attention should be given to positive drainage away from the structure and positive drainage of the aggregate base beneath the floor slab.

Floor Slab Design Parameters

Item	Description
Floor Slab Support ¹	Properly prepared native well-graded sand with silt and gravel, approximately 18 inches of replacement Structural Fill, and a minimum of 6 inches of crushed base course ²
Estimated Modulus of Subgrade Reaction ³	200 pounds per square inch per inch (psi/in) for point loads

1. Floor slabs should be structurally independent of building footings or walls to reduce the possibility of floor slab cracking caused by differential movements between the slab and foundation.
2. Crushed aggregate base course in accordance with The Standard Specifications for the Construction of Roads and Bridges on Federal Highway Projects (FP-14) Table 703-2, Grade E (Base)
3. Modulus of subgrade reaction is an estimated value based upon our experience with the subgrade condition, the requirements noted in **Earthwork**, and the floor slab support as noted in this table. It is provided for point loads. For large area loads the modulus of subgrade reaction would be lower.

The use of a vapor retarder should be considered beneath concrete slabs on grade covered with wood, tile, carpet, or other moisture sensitive or impervious coverings, or when the slab will support equipment sensitive to moisture. When conditions warrant the use of a vapor retarder, the slab designer should refer to ACI 302 and/or ACI 360 for procedures and cautions regarding the use and placement of a vapor retarder.

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Saw-cut control joints should be placed in the slab to help control the location and extent of cracking. For additional recommendations, refer to the ACI Design Manual. Joints or cracks should be sealed with a water-proof, non-extruding compressible compound specifically recommended for heavy duty concrete pavement and wet environments.

Where floor slabs are tied to perimeter walls or turn-down slabs to meet structural or other construction objectives, our experience indicates differential movement between the walls and slabs will likely be observed in adjacent slab expansion joints or floor slab cracks beyond the length of the structural dowels. The Structural Engineer should account for potential differential settlement through use of sufficient control joints, appropriate reinforcing or other means.

Floor Slab Construction Considerations

Finished subgrade, within and for at least 5 feet beyond the floor slab, should be protected from traffic, rutting, or other disturbance and maintained in a relatively moist condition until floor slabs are constructed. If the subgrade should become damaged or desiccated prior to construction of floor slabs, the affected material should be removed and Structural Fill should be added to replace the resulting excavation. Final conditioning of the finished subgrade should be performed immediately prior to placement of the floor slab support course.

The Geotechnical Engineer should approve the condition of the floor slab subgrades immediately prior to placement of the floor slab support course, reinforcing steel, and concrete. Attention should be paid to high traffic areas that were rutted and disturbed earlier, and to areas where backfilled trenches are located.

LATERAL EARTH PRESSURES

Design Parameters

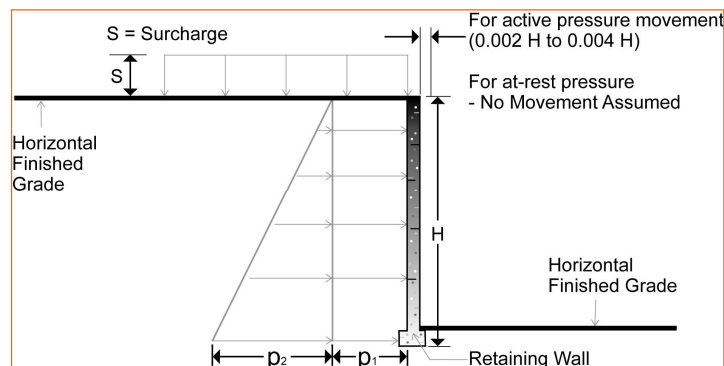
Structures with unbalanced backfill levels on opposite sides should be designed for earth pressures at least equal to values indicated in the following table. Earth pressures will be influenced by structural design of the walls, conditions of wall restraint, methods of construction and/or compaction and the strength of the materials being restrained. Two wall restraint conditions are shown in the diagram below. Active earth pressure is commonly used for design of free-standing cantilever retaining walls and assumes wall movement. The "at-rest" condition assumes no wall movement and is commonly used for basement walls, crawlspace (frost-depth foundation) walls, or other walls restrained at the top. The recommended design lateral earth pressures do not include a factor of safety and do not provide for possible hydrostatic pressure on the walls (unless stated).

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Earth Pressure Conditions	Coefficient for Backfill Type	Equivalent Fluid Density (pcf)	Surcharge Pressure, p_1 (psf)	Earth Pressure, p_2 (psf)
Active (K_a)	Structural Fill - 0.26	35	$(0.26)S$	$(35)H$
	Native Gravel - 0.31	40	$(0.31)S$	$(40)H$
At-Rest (K_o)	Structural Fill - 0.42	55	$(0.42)S$	$(55)H$
	Native Gravel - 0.47	60	$(0.47)S$	$(60)H$
Passive (K_p)	Structural Fill - 3.8	500	---	---
	Native Gravel - 3.3	400	---	---

Applicable conditions to the above include:

- For active earth pressure, wall must rotate about base, with top lateral movements of about $0.002 H$ to $0.004 H$, where H is wall height
- For passive earth pressure to develop, wall must move horizontally to mobilize resistance
- Uniform surcharge, where S is surcharge pressure
- In-situ soil backfill weight a maximum of 125 pcf (native gravel soils), 130 pcf (structural fill)
- Backfill placed in horizontal lifts and compacted between 95 and 98 percent of standard Proctor maximum dry density
- Loading from heavy compaction equipment is not included
- No hydrostatic pressures acting on wall
- No dynamic loading
- No safety factor included
- Ignore passive pressure in frost zone

Backfill placed against structures should consist of granular soils or low plasticity cohesive soils. For the granular values to be valid, the granular backfill must extend out and up from the base of

Geotechnical Engineering Report

Northeast Entrance Housing Upgrades, YELL 309913 Predesign Services

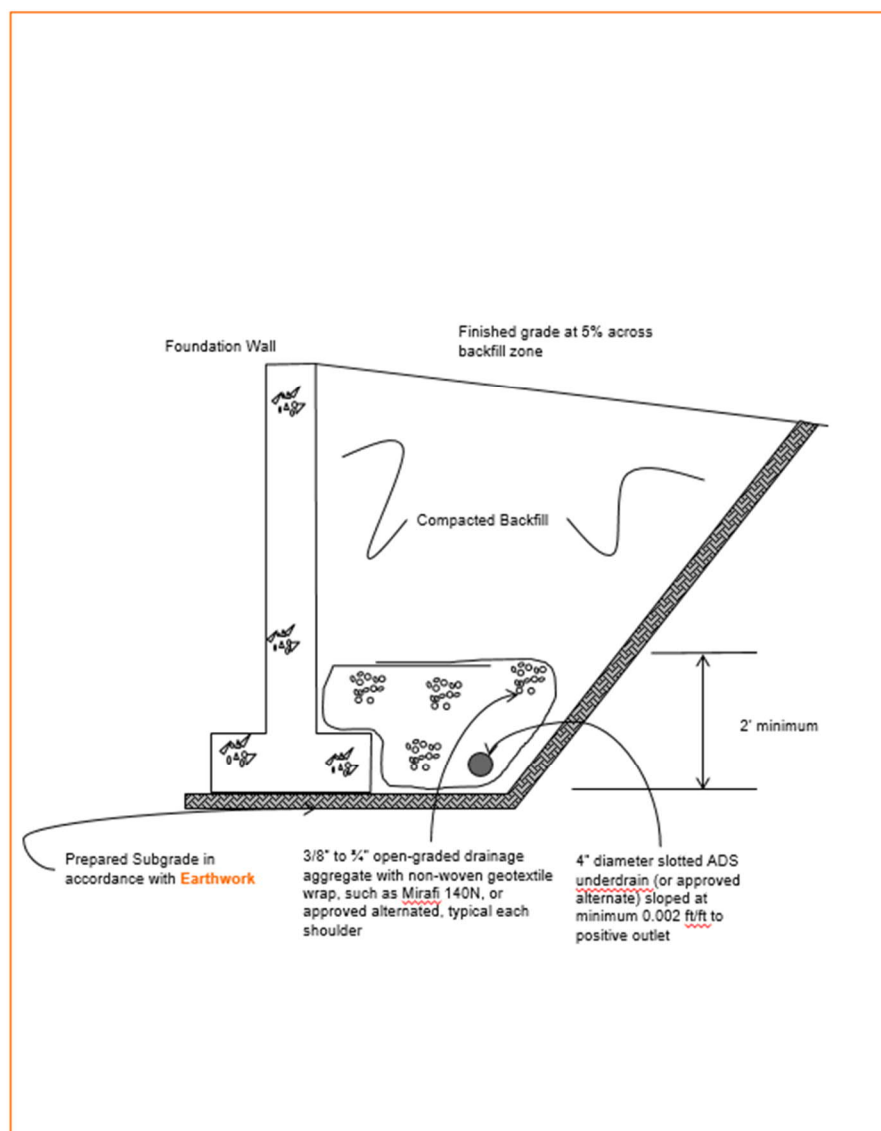
Yellowstone National Park, MT

November 23, 2020 ■ Terracon Project No. C4205059

the wall at an angle of at least 45 and 60 degrees from vertical for the active and passive cases, respectively.

Subsurface Drainage for Below-Grade Walls

A perforated rigid plastic drain line installed behind the base of walls and extending below adjacent grade is recommended to prevent hydrostatic loading on the foundation walls. The invert of a drain line around a below-grade building area or exterior retaining walls should be placed near foundation bearing level as shown in the detail below. The drain line should be sloped to provide positive gravity drainage to daylight or to a sump pit and pump.



FROST CONSIDERATIONS

The soils on this site are frost susceptible, and small amounts of water can affect the performance of the slabs on-grade and sidewalks. Exterior slabs should be anticipated to heave during winter months. If frost action needs to be eliminated in critical areas, we recommend the use of non-frost susceptible (NFS) fill or structural slabs (for instance, structural stoops in front of building doors). Placement of NFS material in large areas may not be feasible; however, the following recommendations are provided to help reduce potential frost heave:

- Provide surface drainage away from the buildings and slabs, and toward the site storm drainage system.
- Install drains around the perimeter of the buildings, stoops, below exterior slabs, and connect them to the storm drainage system.
- Grade clayey subgrades, so groundwater potentially perched in overlying more permeable subgrades, such as sand or aggregate base, slope toward a site drainage system.
- Place NFS fill as backfill beneath slabs critical to the project.
- Place a 3 horizontal to 1 vertical (3H:1V) transition zone between NFS fill and other soils.
- Place NFS materials in critical sidewalk areas.

As an alternative to extending NFS fill to the full frost depth, consideration can be made to placing extruded polystyrene or cellular concrete under a buffer of at least 2 feet of NFS material.

CORROSIVITY

The table below lists the results of laboratory soluble sulfate, electrical resistivity, and pH testing. The values may be used to estimate potential corrosive characteristics of the on-site soils with respect to contact with the various underground materials which will be used for project construction.

Corrosivity Test Results Summary					
Boring	Sample Depth (feet)	Soil Description	Soluble Sulfate (%)	Electrical Resistivity ¹ (Ω-cm)	pH
B-12	5.0	Clayey Gravel with Sand (GC)	0.0019	2,100	8.2

1. Electrical resistivity was performed on a saturated sample

Results of water-soluble sulfate testing indicate that samples of the on-site soils have an exposure class of S0 when classified in accordance with Table 19.3.1.1 of the American Concrete Institute

Geotechnical Engineering Report

Northeast Entrance Housing Upgrades, YELL 309913 Predesign Services

Yellowstone National Park, MT

November 23, 2020 ■ Terracon Project No. C4205059



(ACI) Design Manual. Concrete should be designed in accordance with the provisions of the ACI Design Manual, Section 318, Chapter 19.

GENERAL COMMENTS

Our analysis and opinions are based upon our understanding of the project, the geotechnical conditions in the area, and the data obtained from our site exploration. Natural variations will occur between exploration point locations or due to the modifying effects of construction or weather. The nature and extent of such variations may not become evident until during or after construction. Terracon should be retained as the Geotechnical Engineer, where noted in this report, to provide observation and testing services during pertinent construction phases. If variations appear, we can provide further evaluation and supplemental recommendations. If variations are noted in the absence of our observation and testing services on-site, we should be immediately notified so that we can provide evaluation and supplemental recommendations.

Our Scope of Services does not include either specifically or by implication any environmental or biological (e.g., mold, fungi, bacteria) assessment of the site or identification or prevention of pollutants, hazardous materials or conditions. If the owner is concerned about the potential for such contamination or pollution, other studies should be undertaken.

Our services and any correspondence or collaboration through this system are intended for the sole benefit and exclusive use of our client for specific application to the project discussed and are accomplished in accordance with generally accepted geotechnical engineering practices with no third-party beneficiaries intended. Any third-party access to services or correspondence is solely for information purposes to support the services provided by Terracon to our client. Reliance upon the services and any work product is limited to our client, and is not intended for third parties. Any use or reliance of the provided information by third parties is done solely at their own risk. No warranties, either express or implied, are intended or made.

Site characteristics as provided are for design purposes and not to estimate excavation cost. Any use of our report in that regard is done at the sole risk of the excavating cost estimator as there may be variations on the site that are not apparent in the data that could significantly impact excavation cost. Any parties charged with estimating excavation costs should seek their own site characterization for specific purposes to obtain the specific level of detail necessary for costing. Site safety, and cost estimating including, excavation support, and dewatering requirements/design are the responsibility of others. If changes in the nature, design, or location of the project are planned, our conclusions and recommendations shall not be considered valid unless we review the changes and either verify or modify our conclusions in writing.

ATTACHMENTS

EXPLORATION AND TESTING PROCEDURES

Field Exploration

Number of Borings	Boring Depth (feet)	Planned Location
1	14.1	Planned building upgrade areas

Boring Layout and Elevations: Unless otherwise noted, Terracon personnel provided the boring layout. Coordinates were obtained with a handheld GPS unit (estimated horizontal accuracy of about ± 10 feet) and elevation was provided by DJ&A as determined during site survey activities.

Subsurface Exploration Procedures: Our exploration was completed on October 19, 2020, when we advanced the boring with a subcontracted, truck-mounted, Mobile B-57 drill rig operated by Boland Drilling using continuous-flight, hollow-stem augers. In general, four samples were obtained in the upper 10 feet of the boring and at intervals of 5 feet thereafter. In the split-barrel sampling procedure, a standard 2-inch outer diameter split-barrel sampling spoon was driven into the ground by a 140-pound automatic hammer falling a distance of 30 inches. The number of blows required to advance the sampling spoon the last 12 inches of a normal 18-inch penetration is recorded as the Standard Penetration Test (SPT) resistance value. The SPT resistance values, also referred to as N-values, are indicated on the boring log at the test depths. A 3-inch O.D. split-barrel sampling spoon with 2.5-inch I.D. ring-lined sampler was used for sampling in the upper 7 feet. Ring-lined, split-barrel sampling procedures are similar to standard split spoon sampling procedure; however, blow counts are typically recorded for 6-inch intervals for a total of 12 inches of penetration. We observed and recorded groundwater levels during drilling and sampling. For safety purposes, the boring was backfilled with auger cuttings after completion.

The sampling depths, penetration distances, and other sampling information were recorded on the field boring log. The samples were placed in appropriate containers and taken to our soil laboratory for testing and classification by a Geotechnical Engineer. Our exploration team prepared a field boring log as part of the drilling operations. This field log included visual classifications of the materials encountered during drilling and our interpretation of the subsurface conditions between samples. A final boring log was prepared from the field log. The final boring log represents the Geotechnical Engineer's interpretation of the field log and include modifications based on observations and tests of the samples in our laboratory.

Laboratory Testing

The project engineer reviewed the field data and assigned laboratory tests to understand the engineering properties of the various soil strata, as necessary, for this project. Procedural standards noted below are for reference to methodology in general. In some cases, variations to methods were applied because of local practice or professional judgment. Standards noted below

Geotechnical Engineering Report

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Yellowstone National Park, MT

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include reference to other, related standards. Such references are not necessarily applicable to describe the specific test performed.

- ASTM D2216 Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
- ASTM D4318 Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
- ASTM D422 Standard Test Method for Particle-Size Analysis of Soils

The laboratory testing program included examination of soil samples by an engineer. Based on the material's texture and plasticity, we described and classified the soil samples in accordance with the Unified Soil Classification System.

Other Testing: Soil chemistry (minimum laboratory soil resistivity, pH, and soluble sulfate content)

Geotechnical Engineering Report

Northeast Entrance Housing Upgrades, YELL 309913 Predesign Services

Yellowstone National Park, MT

November 23, 2020 ■ Terracon Project No. C4205059



PHOTOGRAPHY LOG



View looking south at Boring B-12



View looking east at Boring B-12



View of auger cuttings at Boring B-12

SITE LOCATION AND EXPLORATION PLANS

Contents:

Site Location Plan

Exploration Plan

Note: All attachments are one page unless noted above.

SITE LOCATION

Northeast Entrance Housing Upgrades, YELL 309913 Predesign Services
Yellowstone National Park, MT
November 23, 2020 ■ Terracon Project No. C4205059

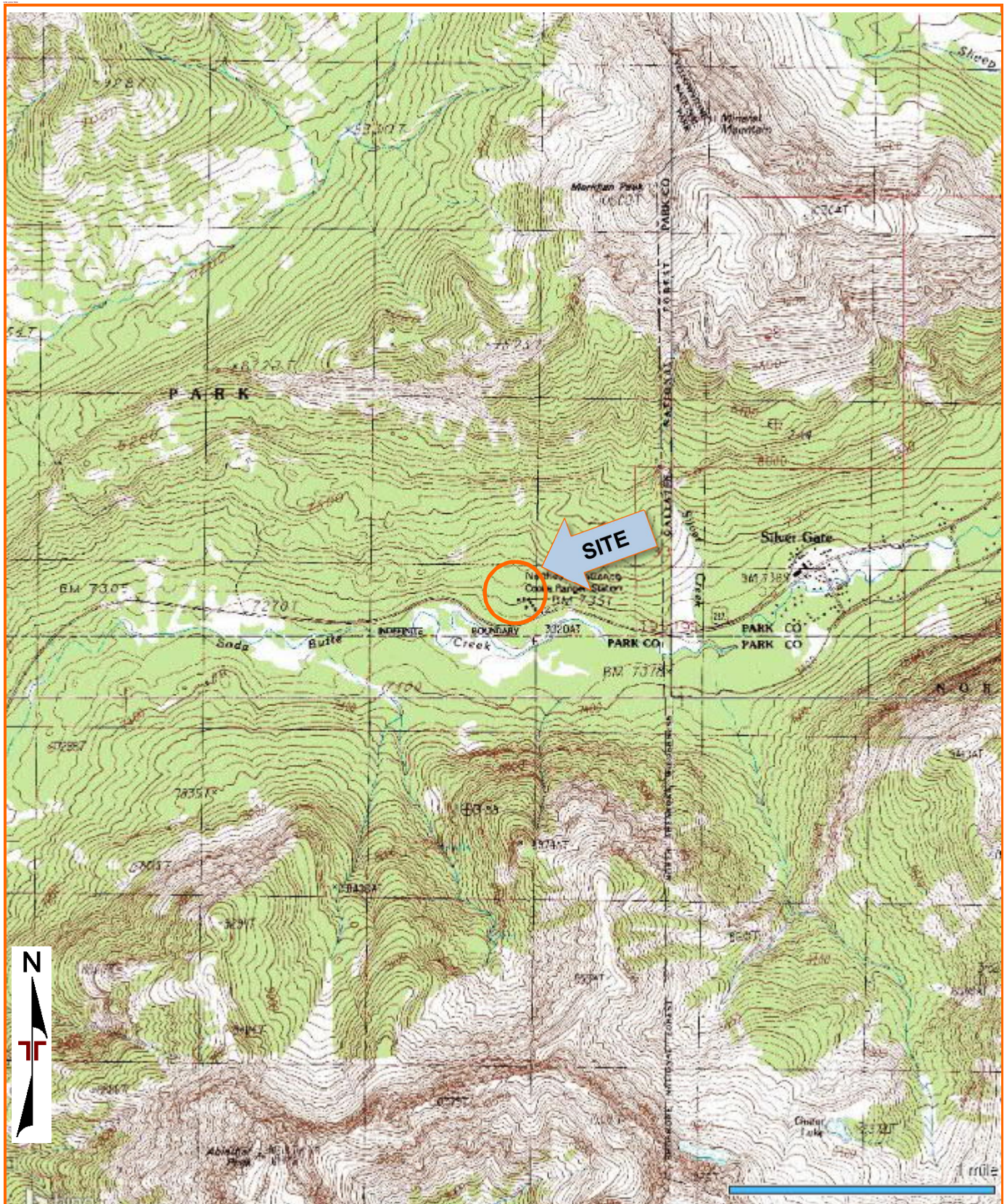


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

MAP PROVIDED BY MICROSOFT BING MAPS

EXPLORATION PLAN

Northeast Entrance Housing Upgrades, YELL 309913 Predesign Services

Yellowstone National Park, MT

November 23, 2020 ■ Terracon Project No. C4205059

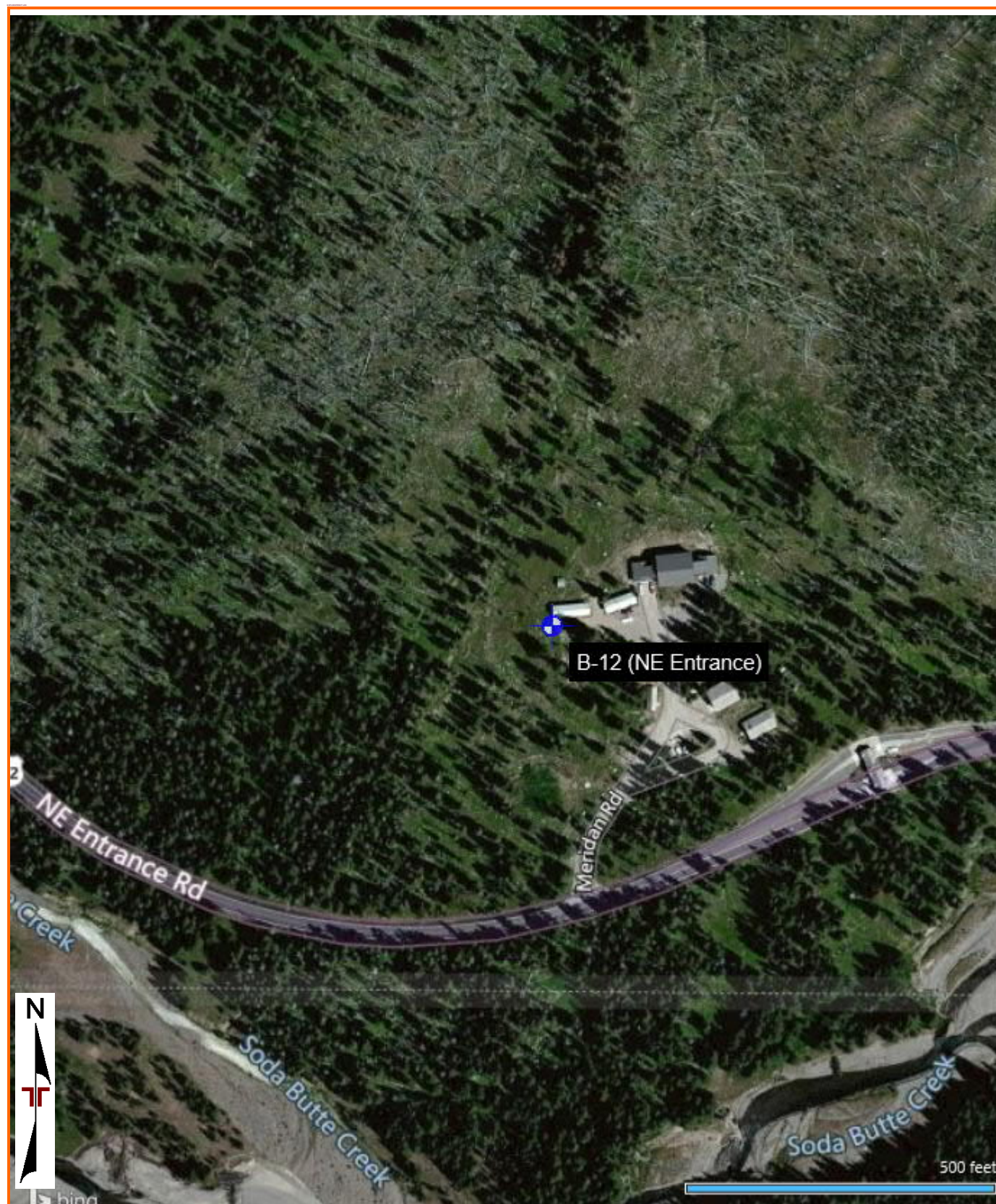


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

MAP PROVIDED BY MICROSOFT BING MAPS

EXPLORATION RESULTS

Contents:

Boring Log (B-12)

Atterberg Limits

Grain Size Distribution

Minimum Laboratory Soil Resistivity

Energy Laboratories Analytical Summary Report

Note: All attachments are one page unless noted above.

BORING LOG NO. B-12 (NE Entrance)

Page 1 of 1

PROJECT: Yellowstone National Park (YELL 309913) - 8 Sites Predesign Phase Geotechnical

CLIENT: DJ&A, PC
Missoula, MT

SITE: Northeast Entrance Housing Facility
Yellowstone National Park, MT

GRAPHIC LOG	LOCATION See Exploration Plan		DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS	
	Latitude: 45.0051° Longitude: -110.0124°	Surface Elev.: 7405.6 (Ft.)							LL-PL-PI	
DEPTH	ELEVATION (Ft.)									
	FILL - SILTY SAND (SM) , brown and dark brown, loose, surface gravels, some scattered gravels with depth, trace roots/organics		2.5			1-4-5 N=9	16.8			
	CLAYEY GRAVEL WITH SAND (GC) , light brown and brown, medium dense to dense, scattered gravels, trace oxidation		5			2-2-3 N=5	16.0			
	large cobble/boulder		10			7-12-14-17	17.2		37-19-18	
			14.0			7-5-6 N=11	13.3			
	BEDROCK , gray, hard, severely to completely weathered, poorly cemented, auger refusal, sss bouncing at 14.1 Feet		14.1			8-7-4 N=11	8.0			
						50/1"	5.4			

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic
Logged by A. Proud

Advancement Method:
3-1/4 inch hollowstem auger

See [Exploration and Testing Procedures](#) for a description of field and laboratory procedures used and additional data (if any).

Notes:

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

See [Supporting Information](#) for explanation of symbols and abbreviations.

Elevations were provided by DJ&A Surveying.

WATER LEVEL OBSERVATIONS

Groundwater not encountered

Terracon
1392 13th Ave SW
Great Falls, MT

Boring Started: 10-19-2020

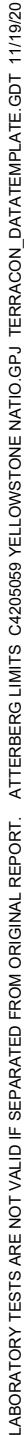
Boring Completed: 10-19-2020

Drill Rig: B59 Foremost Mobile

Driller: C. Tigart

Project No.: C4205059

ASTM D4318

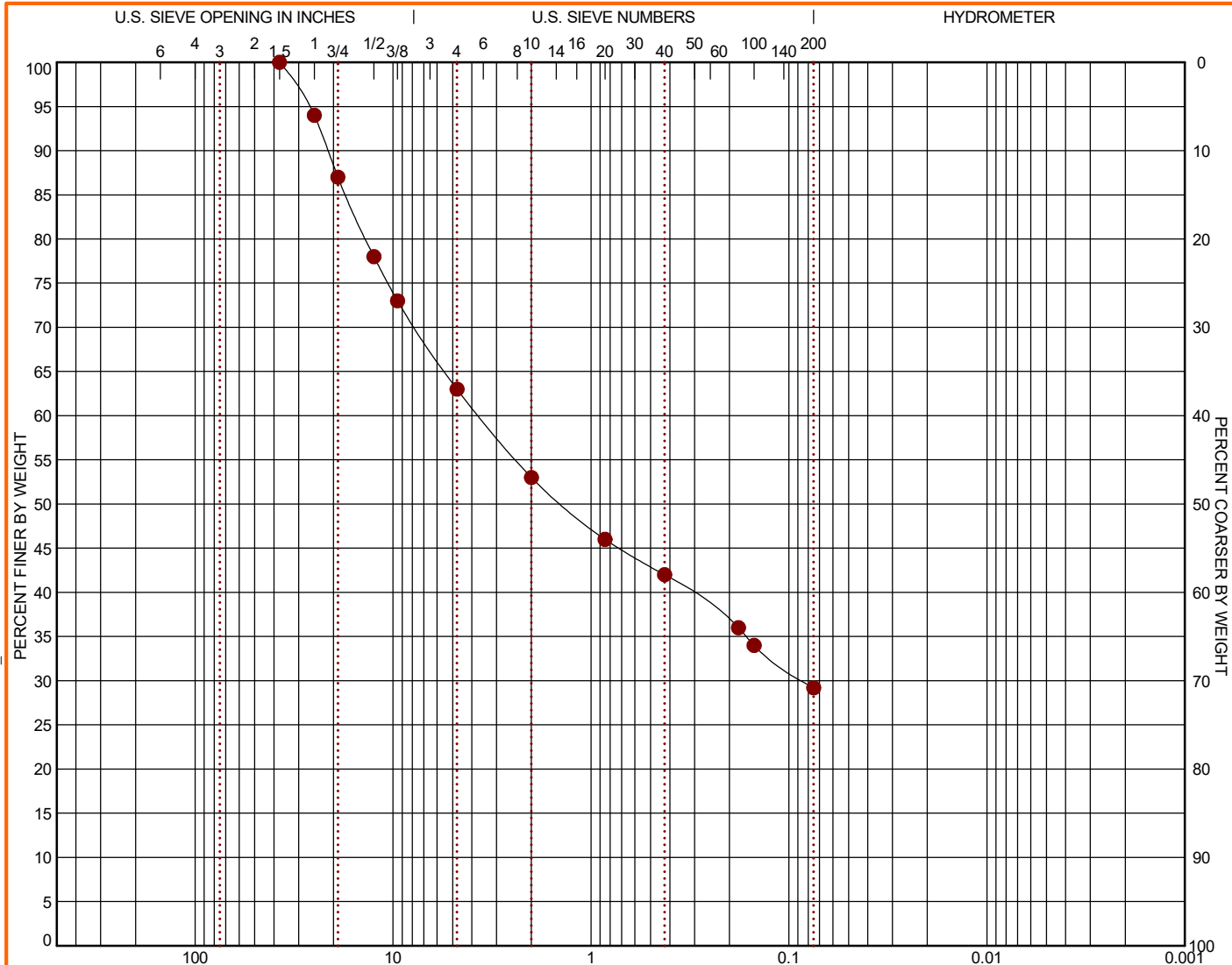


CLIENT: DJ&A, PC
Missoula, MT

GRAIN SIZE DISTRIBUTION

ASTM D422 / ASTM C136

LABORATORY TESTS ARE NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GRAIN SIZE: USCS 1 C4205059 YELLOWSTONE NATIO.GPJ TERRACON_DATATEMPLATE.GDT 11/19/20



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

BORING ID	DEPTH	% COBBLES	% GRAVEL	% SAND	% SILT	% FINES	% CLAY	USCS
● B-12 (NE Entrance)	5 - 7	0.0	37.0	33.8		29.2		GC

GRAIN SIZE				SOIL DESCRIPTION			
	●			Sieve	% Finer	Sieve	% Finer
D ₆₀	3.664			1 1/2"	100.0	●	CLAYEY GRAVEL with SAND (GC)
D ₃₀	0.084			1"	94.0		
D ₁₀				3/4"	87.0		
				1/2"	78.0		
				3/8"	73.0		
				#4	63.0		
				#10	53.0		
				#20	46.0		
				#40	42.0		
				#80	36.0		
				#100	34.0		
				#200	29.2		
COEFFICIENTS				REMARKS			
	●			●			
C _c							
C _u							

PROJECT: Yellowstone National Park (YELL 309913) - 8 Sites Predesign Phase Geotechnical

SITE: Northeast Entrance Housing Facility
Yellowstone National Park, MT

Terracon

1392 13th Ave SW
Great Falls, MT

PROJECT NUMBER: C4205059

CLIENT: DJ&A, PC
Missoula, MT



Minimum Soil Resistivity

AASHTO T288-92 (1996)

1392 13th Ave SW, Great Falls, Montana 59404

(406) 453-5400

Project: Northeast Entrance Housing Upgrades, YELL 309913 Predesig

Date: 11/4/2020

Job No: C4205059

Report No.: C4205059

Sample No.: Split Spoon

Drill Hole: B-12

Depth: 5.0' - 7.0'

Tested By: AP

Classification: Clayey Gravel with Sand (SC)

Reviewed By: MDH

Material Size: -#10

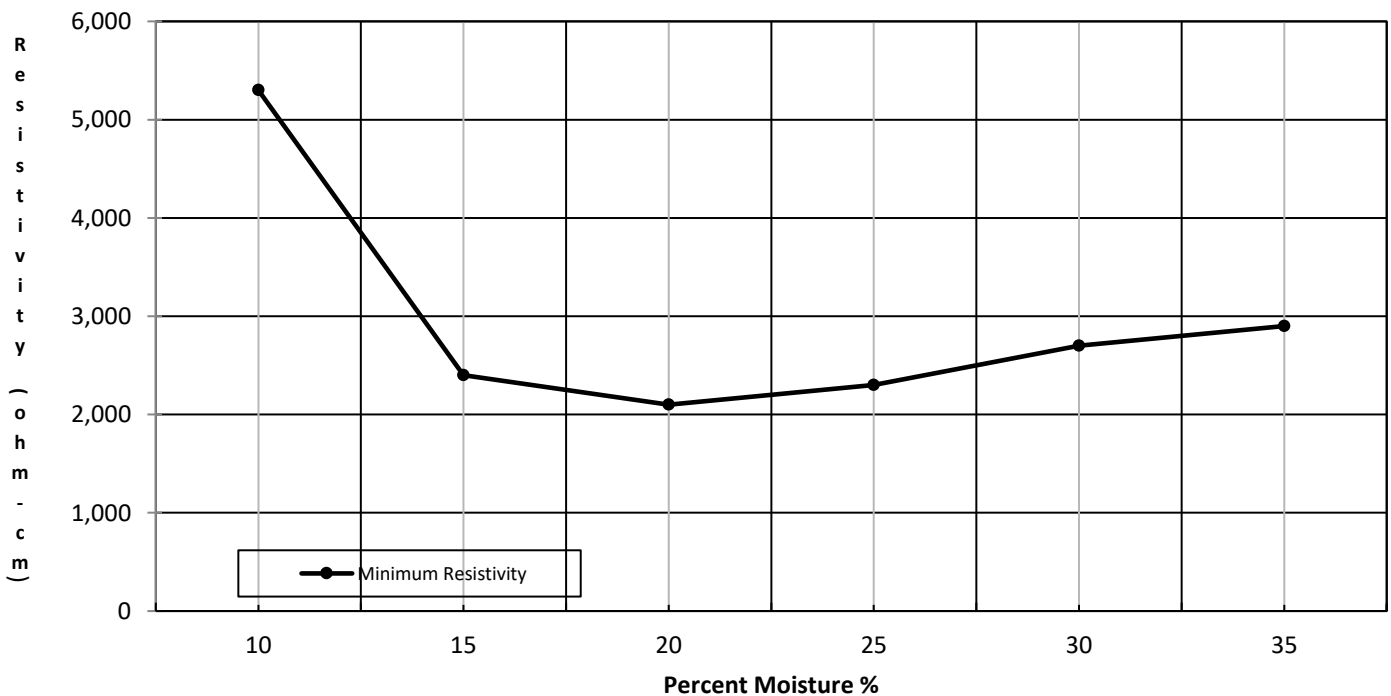
Remarks: pH = 8.2, Sulfate Content = .0019% as tested by Energy Labortories in Helena, MT

Soil Data (As Received)

wet (g):	<u>na</u>	Weight of Sample (g):	<u>200</u>	Initial Moisture %:	<u>10</u>
dry (g):	<u>na</u>	As Received MC%:	<u>na</u>	5% Increments (g):	<u>10</u>
pan (g):	<u>na</u>	Beginning MC%:	<u>10</u>	Resistivity (ohm-cm):	<u>2,100</u>

% Moisture Added	Reading	Box Constant	Multilplier	Resistivity (ohm-cm)
10	5.3	10	100	5,300
15	2.4	10	100	2,400
20	2.1	10	100	2,100
25	2.3	10	100	2,300
30	2.7	10	100	2,700
35	2.9	10	100	2,900

Minimum Resistivity





ANALYTICAL SUMMARY REPORT

November 18, 2020

Terracon Consultants
1392 13th Ave S W
Great Falls, MT 59404-3155

Work Order: H20110098

Project Name: Yellowstone National Park (YNP)

Energy Laboratories Inc Helena MT received the following 8 samples for Terracon Consultants on 11/4/2020 for analysis.

Lab ID	Client Sample ID	Collect Date	Receive Date	Matrix	Test
H20110098-001	YNP, B2; 5-7'	11/03/20 13:00	11/04/20	Soil	Anions, Water Extractable pH, 1:X Water Extractable DI Water Soil Extract ASA10-3 Soil Preparation USDA1
H20110098-002	YNP, B4; 5-7'	11/03/20 13:00	11/04/20	Soil	Anions, Water Extractable pH, 1:X Water Extractable DI Water Soil Extract ASA10-3
H20110098-003	YNP, B5; 2.5-4'	11/03/20 13:00	11/04/20	Soil	Same As Above
H20110098-004	YNP, B6; 5-7'	11/03/20 13:00	11/04/20	Soil	Same As Above
H20110098-005	YNP, B9; 5-7'	11/03/20 13:00	11/04/20	Soil	Same As Above
H20110098-006	YNP, B10; 5-6.5'	11/03/20 13:00	11/04/20	Soil	Same As Above
H20110098-007	YNP, B11; 5-7'	11/03/20 13:00	11/04/20	Soil	Same As Above
H20110098-008	YNP, B12; 5-7'	11/03/20 13:00	11/04/20	Soil	Same As Above

The analyses presented in this report were performed by Energy Laboratories, Inc., 3161 E. Lyndale Ave., Helena, MT 59604, unless otherwise noted. Any exceptions or problems with the analyses are noted in the Laboratory Analytical Report, the QA/QC Summary Report, or the Case Narrative. Any issues encountered during sample receipt are documented in the Work Order Receipt Checklist.

The results as reported relate only to the item(s) submitted for testing. This report shall be used or copied only in its entirety. Energy Laboratories, Inc. is not responsible for the consequences arising from the use of a partial report.

If you have any questions regarding these test results, please contact your Project Manager.

Report Approved By:


Project Manager - Helena, MT

Digitally signed by
Wanda Johnson
Date: 2020.11.18 13:07:29 -07:00



CLIENT: Terracon Consultants
Project: Yellowstone National Park (YNP)
Work Order: H20110098

Revised Date: 11/18/20

Report Date: 11/18/20

CASE NARRATIVE

Revised Report due to the project name was incorrect. No data has changed. wj 11/18/2020



LABORATORY ANALYTICAL REPORT

Prepared by Helena, MT Branch

Client: Terracon Consultants
Project: Yellowstone National Park (YNP)
Lab ID: H20110098-001
Client Sample ID: YNP, B2; 5-7'

Revised Date: 11/18/20
Report Date: 11/18/20
Collection Date: 11/03/20 13:00
Date Received: 11/04/20
Matrix: Soil

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
1:X SOIL:WATER							
pH, 1:2	7.8	s.u.		0.1		ASA10-3	11/08/20 10:55 / sah
WATER EXTRACTABLE							
Sulfate, 1:2	3	mg/kg		1		E300.0	11/12/20 02:00 / RAT

Report
Definitions: RL - Analyte Reporting Limit
QCL - Quality Control Limit

MCL - Maximum Contaminant Level
ND - Not detected at the Reporting Limit (RL)



LABORATORY ANALYTICAL REPORT

Prepared by Helena, MT Branch

Client: Terracon Consultants
Project: Yellowstone National Park (YNP)
Lab ID: H20110098-002
Client Sample ID: YNP, B4; 5-7'

Revised Date: 11/18/20
Report Date: 11/18/20
Collection Date: 11/03/20 13:00
Date Received: 11/04/20
Matrix: Soil

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
1:X SOIL:WATER							
pH, 1:2	7.4	s.u.		0.1		ASA10-3	11/08/20 10:58 / sah
WATER EXTRACTABLE							
Sulfate, 1:2	4	mg/kg		1		E300.0	11/12/20 02:14 / RAT

Report
Definitions: RL - Analyte Reporting Limit
QCL - Quality Control Limit

MCL - Maximum Contaminant Level
ND - Not detected at the Reporting Limit (RL)



LABORATORY ANALYTICAL REPORT

Prepared by Helena, MT Branch

Client: Terracon Consultants
Project: Yellowstone National Park (YNP)
Lab ID: H20110098-003
Client Sample ID: YNP, B5; 2.5-4'

Revised Date: 11/18/20
Report Date: 11/18/20
Collection Date: 11/03/20 13:00
Date Received: 11/04/20
Matrix: Soil

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
1:X SOIL:WATER							
pH, 1:2	7.1	s.u.		0.1		ASA10-3	11/08/20 11:01 / sah
WATER EXTRACTABLE							
Sulfate, 1:2	13	mg/kg		1		E300.0	11/12/20 03:26 / RAT

Report
Definitions: RL - Analyte Reporting Limit
QCL - Quality Control Limit

MCL - Maximum Contaminant Level
ND - Not detected at the Reporting Limit (RL)



LABORATORY ANALYTICAL REPORT

Prepared by Helena, MT Branch

Client: Terracon Consultants
Project: Yellowstone National Park (YNP)
Lab ID: H20110098-004
Client Sample ID: YNP, B6; 5-7'

Revised Date: 11/18/20
Report Date: 11/18/20
Collection Date: 11/03/20 13:00
Date Received: 11/04/20
Matrix: Soil

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
1:X SOIL:WATER							
pH, 1:2	7.8	s.u.		0.1		ASA10-3	11/08/20 11:03 / sah
WATER EXTRACTABLE							
Sulfate, 1:2	23	mg/kg		1		E300.0	11/12/20 03:41 / RAT

Report
Definitions: RL - Analyte Reporting Limit
QCL - Quality Control Limit

MCL - Maximum Contaminant Level
ND - Not detected at the Reporting Limit (RL)



LABORATORY ANALYTICAL REPORT

Prepared by Helena, MT Branch

Client: Terracon Consultants
Project: Yellowstone National Park (YNP)
Lab ID: H20110098-005
Client Sample ID: YNP, B9; 5-7'

Revised Date: 11/18/20
Report Date: 11/18/20
Collection Date: 11/03/20 13:00
Date Received: 11/04/20
Matrix: Soil

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
1:X SOIL:WATER							
pH, 1:2	7.6	s.u.		0.1		ASA10-3	11/08/20 11:05 / sah
WATER EXTRACTABLE							
Sulfate, 1:2	6	mg/kg		1		E300.0	11/12/20 03:55 / RAT

Report
Definitions: RL - Analyte Reporting Limit
QCL - Quality Control Limit

MCL - Maximum Contaminant Level
ND - Not detected at the Reporting Limit (RL)



LABORATORY ANALYTICAL REPORT

Prepared by Helena, MT Branch

Client: Terracon Consultants
Project: Yellowstone National Park (YNP)
Lab ID: H20110098-006
Client Sample ID: YNP, B10; 5-6.5'

Revised Date: 11/18/20
Report Date: 11/18/20
Collection Date: 11/03/20 13:00
Date Received: 11/04/20
Matrix: Soil

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
1:X SOIL:WATER							
pH, 1:2	7.6	s.u.		0.1		ASA10-3	11/08/20 11:08 / sah
WATER EXTRACTABLE							
Sulfate, 1:2	9	mg/kg		1		E300.0	11/12/20 04:09 / RAT

Report
Definitions: RL - Analyte Reporting Limit
QCL - Quality Control Limit

MCL - Maximum Contaminant Level
ND - Not detected at the Reporting Limit (RL)



LABORATORY ANALYTICAL REPORT

Prepared by Helena, MT Branch

Client: Terracon Consultants
Project: Yellowstone National Park (YNP)
Lab ID: H20110098-007
Client Sample ID: YNP, B11; 5-7'

Revised Date: 11/18/20
Report Date: 11/18/20
Collection Date: 11/03/20 13:00
Date Received: 11/04/20
Matrix: Soil

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
1:X SOIL:WATER							
pH, 1:2	5.7	s.u.		0.1		ASA10-3	11/08/20 11:09 / sah
WATER EXTRACTABLE							
Sulfate, 1:2	40	mg/kg		1		E300.0	11/12/20 04:24 / RAT

Report
Definitions: RL - Analyte Reporting Limit
QCL - Quality Control Limit

MCL - Maximum Contaminant Level
ND - Not detected at the Reporting Limit (RL)



LABORATORY ANALYTICAL REPORT

Prepared by Helena, MT Branch

Client: Terracon Consultants
Project: Yellowstone National Park (YNP)
Lab ID: H20110098-008
Client Sample ID: YNP, B12; 5-7'

Revised Date: 11/18/20
Report Date: 11/18/20
Collection Date: 11/03/20 13:00
Date Received: 11/04/20
Matrix: Soil

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
1:X SOIL:WATER							
pH, 1:2	8.2	s.u.		0.1		ASA10-3	11/08/20 11:11 / sah
WATER EXTRACTABLE							
Sulfate, 1:2	19	mg/kg		1		E300.0	11/12/20 04:38 / RAT

Report
Definitions: RL - Analyte Reporting Limit
QCL - Quality Control Limit

MCL - Maximum Contaminant Level
ND - Not detected at the Reporting Limit (RL)



QA/QC Summary Report

Prepared by Helena, MT Branch

Revised Date: 11/18/20

Client: Terracon Consultants

Work Order: H20110098

Report Date: 11/18/20

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: ASA10-3										al Run: SOIL PH METER - ORION A211_201108A
Lab ID: ICV_1_201108_1										11/08/20 10:47
pH, 1:2		10.0	s.u.	0.10	100	99	101			
Lab ID: CCV_1_201108_1										11/08/20 10:50
pH, 1:2		6.99	s.u.	0.10	100	98.6	101.4			
Lab ID: CCV1_1_201108_1										11/08/20 10:51
pH, 1:2		4.00	s.u.	0.10	100	97.5	102.5			
Lab ID: CCV_3_201108_1										11/08/20 11:13
pH, 1:2		7.00	s.u.	0.10	100	98.6	101.4			

Qualifiers:

RL - Analyte Reporting Limit

ND - Not detected at the Reporting Limit (RL)



QA/QC Summary Report

Prepared by Helena, MT Branch

Revised Date: 11/18/20

Client: Terracon Consultants

Work Order: H20110098

Report Date: 11/18/20

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual	
Method:	E300.0								Analytical Run: IC METROHM_201110B		
Lab ID:	ICV	Initial Calibration Verification Standard							11/11/20 02:07		
Sulfate		398	mg/L	1.0	100	90	110				
Lab ID:	CCV	Continuing Calibration Verification Standard							11/11/20 02:50		
Sulfate		207	mg/L	1.0	104	90	110				
Lab ID:	CCB	Continuing Calibration Blank							11/11/20 03:19		
Sulfate		0.0290	mg/L	1.0							
Method:	E300.0								Batch: 54116		
Lab ID:	MB-54116	Method Blank			Run: IC METROHM_201110B				11/12/20 01:31		
Sulfate, 1:2		0.2	mg/kg	0.08							
Lab ID:	LCS-54116	Laboratory Control Sample			Run: IC METROHM_201110B				11/12/20 01:46		
Sulfate, 1:2		666	mg/kg	1.0	112	70	130				
Lab ID:	H20110098-002ADUP	Sample Duplicate			Run: IC METROHM_201110B				11/12/20 02:29		
Sulfate, 1:2		4.27	mg/kg	1.0					9.1	20	
Lab ID:	H20110098-008AMS	Sample Matrix Spike			Run: IC METROHM_201110B				11/12/20 04:53		
Sulfate, 1:2		999	mg/kg	1.1	98	90	110				

Qualifiers:

RL - Analyte Reporting Limit

ND - Not detected at the Reporting Limit (RL)



Work Order Receipt Checklist

Terracon Consultants

H20110098

Login completed by: Elizabeth E. Hodgson

Date Received: 11/4/2020

Reviewed by: BL2000\sdull

Received by: kjk

Reviewed Date: 11/8/2020

Carrier name: FedEx Ground

Shipping container/cooler in good condition?	Yes ☒	No ☐	Not Present ☐
Custody seals intact on all shipping container(s)/cooler(s)?	Yes ☐	No ☐	Not Present ☒
Custody seals intact on all sample bottles?	Yes ☐	No ☐	Not Present ☒
Chain of custody present?	Yes ☒	No ☐	
Chain of custody signed when relinquished and received?	Yes ☒	No ☐	
Chain of custody agrees with sample labels?	Yes ☐	No ☒	
Samples in proper container/bottle?	Yes ☒	No ☐	
Sample containers intact?	Yes ☒	No ☐	
Sufficient sample volume for indicated test?	Yes ☒	No ☐	
All samples received within holding time? (Exclude analyses that are considered field parameters such as pH, DO, Res Cl, Sulfite, Ferrous Iron, etc.)	Yes ☒	No ☐	
Temp Blank received in all shipping container(s)/cooler(s)?	Yes ☐	No ☒	Not Applicable ☐
Container/Temp Blank temperature:	19.7°C No Ice		
Water - VOA vials have zero headspace?	Yes ☐	No ☐	No VOA vials submitted ☒
Water - pH acceptable upon receipt?	Yes ☐	No ☐	Not Applicable ☒

Standard Reporting Procedures:

Lab measurement of analytes considered field parameters that require analysis within 15 minutes of sampling such as pH, Dissolved Oxygen and Residual Chlorine, are qualified as being analyzed outside of recommended holding time.

Solid/soil samples are reported on a wet weight basis (as received) unless specifically indicated. If moisture corrected, data units are typically noted as –dry. For agricultural and mining soil parameters/characteristics, all samples are dried and ground prior to sample analysis.

Radiochemical precision results represent a 2-sigma Total Measurement Uncertainty.

Contact and Corrective Action Comments:

No time on the COC when the client relinquished the COC. No time or date on sample containers. No time on COC so estimated in lab. Punctuation inconsistent on samples. EH 11/4/2020

Chain Of Custody and Analytical Request Record

Page 1 of 2

f 14

Company Name: Terracon		Project Name, PWS #, Permit #, Etc. Yellowstone National Park (YNP)	
Report Mail Address: 1392 13th Ave SW Great Falls, MT 59404		Contact Name, Phone, Fax, E-mail: Adam Proud 406-788-7632 adam.proud@terracon.com	
Invoice Address: same as above		Invoice Contact and Phone #: Jessica Wharton, 406-453-5400	
Purchase Order #:		ELI Quote #:	
Report Required For: POTW/WWT ☐ DW ☐ Other _____		Notify ELI prior to RUSH sample submital for additional charges and scheduling	
Special Report Formats - ELI must be notified prior to sample submital for the following: NELAC ☐ A2LA ☐ Level IV ☐ Other _____ EDD/EDT ☐ Formal _____		Comments:	
SAMPLE IDENTIFICATION (Name, Location, Interval, etc.)		Shipped by: Fed Ex Fed	
1 YNP, B2, 5-7'		Receipt Temp 19.7 °C	
2 YNP, B4, 5-7'		Custody Seal Y ☒ N ☐	
3 YNP, B5, 2.5-4'		Intact Y ☒ N ☐	
4 YNP, B6, 5-7'		Signature LAB ID	
5 YNP, B9, 5-7'		Match	
6 YNP, B10, 5-6.5'			
7 YNP, B11, 5-7'			
8 YNP, B12, 5-7'			
9			
10			
Relinquished by (print): Adam Proud		Date/Time: 11-3-2020	
Relinquished by (print): Signature: Adam Proud		Received by (print): Kevin Kent	
Date/Time: 11-3-2020		Date/Time: 11-4-20 1221	
Signature:		Signature:	
Custody Record MUST be Signed		LABORATORY USE ONLY # of fractions	
Sample Disposal: Return to client: _____		Lab Disposal: X	

In certain circumstances, samples submitted to Energy Laboratories, Inc. may be subcontracted to other certified laboratories in order to complete the analysis requested. This serves as notice of this possibility. All subcontracted data will be clearly annotated on your analytical report.

Visit our website at www.energylab.com for additional information, downloadable fee schedule, forms, & links.

SUPPORTING INFORMATION

Contents:

General Notes

Unified Soil Classification System

Note: All attachments are one page unless noted above.

GENERAL NOTES

DESCRIPTION OF SYMBOLS AND ABBREVIATIONS

Yellowstone National Park (YELL 309913) - 8 Sites Predesign Phase Geotechnical

Yellowstone National Park, WY ■ Terracon Project No. C4205059

SAMPLING	WATER LEVEL	FIELD TESTS
 Ring Sampler  Split Spoon	 Water Initially Encountered  Water Level After a Specified Period of Time  Water Level After a Specified Period of Time  Cave In Encountered Water levels indicated on the soil boring logs are the levels measured in the borehole at the times indicated. Groundwater level variations will occur over time. In low permeability soils, accurate determination of groundwater levels is not possible with short term water level observations.	N Standard Penetration Test Resistance (Blows/Ft.) (HP) Hand Penetrometer (T) Torvane (DCP) Dynamic Cone Penetrometer UC Unconfined Compressive Strength (PID) Photo-Ionization Detector (OVA) Organic Vapor Analyzer

DESCRIPTIVE SOIL CLASSIFICATION

Soil classification as noted on the soil boring logs is based Unified Soil Classification System. Where sufficient laboratory data exist to classify the soils consistent with ASTM D2487 "Classification of Soils for Engineering Purposes" this procedure is used. ASTM D2488 "Description and Identification of Soils (Visual-Manual Procedure)" is also used to classify the soils, particularly where insufficient laboratory data exist to classify the soils in accordance with ASTM D2487. In addition to USCS classification, coarse grained soils are classified on the basis of their in-place relative density, and fine-grained soils are classified on the basis of their consistency. See "Strength Terms" table below for details. The ASTM standards noted above are for reference to methodology in general. In some cases, variations to methods are applied as a result of local practice or professional judgment.

LOCATION AND ELEVATION NOTES

Exploration point locations as shown on the Exploration Plan and as noted on the soil boring logs in the form of Latitude and Longitude are approximate. See [Exploration and Testing Procedures](#) in the report for the methods used to locate the exploration points for this project. Surface elevation data annotated with +/- indicates that no actual topographical survey was conducted to confirm the surface elevation. Instead, the surface elevation was approximately determined from topographic maps of the area.

STRENGTH TERMS

RELATIVE DENSITY OF COARSE-GRAINED SOILS (More than 50% retained on No. 200 sieve.) Density determined by Standard Penetration Resistance			CONSISTENCY OF FINE-GRAINED SOILS (50% or more passing the No. 200 sieve.) Consistency determined by laboratory shear strength testing, field visual-manual procedures or standard penetration resistance			
Descriptive Term (Density)	Standard Penetration or N-Value Blows/Ft.	Ring Sampler Blows/Ft.	Descriptive Term (Consistency)	Unconfined Compressive Strength Qu, (psf)	Standard Penetration or N-Value Blows/Ft.	Ring Sampler Blows/Ft.
Very Loose	0 - 3	0 - 6	Very Soft	less than 500	0 - 1	< 3
Loose	4 - 9	7 - 18	Soft	500 to 1,000	2 - 4	3 - 4
Medium Dense	10 - 29	19 - 58	Medium Stiff	1,000 to 2,000	4 - 8	5 - 9
Dense	30 - 50	59 - 98	Stiff	2,000 to 4,000	8 - 15	10 - 18
Very Dense	> 50	> 99	Very Stiff	4,000 to 8,000	15 - 30	19 - 42
			Hard	> 8,000	> 30	> 42

RELEVANCE OF SOIL BORING LOG

The soil boring logs contained within this document are intended for application to the project as described in this document. Use of these soil boring logs for any other purpose may not be appropriate.

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests ^A					Soil Classification	
					Group Symbol	Group Name ^B
Coarse-Grained Soils: More than 50% retained on No. 200 sieve	Gravels: More than 50% of coarse fraction retained on No. 4 sieve	Clean Gravels: Less than 5% fines ^C	$Cu \geq 4$ and $1 \leq Cc \leq 3$ ^E	GW	Well-graded gravel ^F	
			$Cu < 4$ and/or $[Cc < 1$ or $Cc > 3.0]$ ^E	GP	Poorly graded gravel ^F	
		Gravels with Fines: More than 12% fines ^C	Fines classify as ML or MH	GM	Silty gravel ^{F, G, H}	
			Fines classify as CL or CH	GC	Clayey gravel ^{F, G, H}	
	Sands: 50% or more of coarse fraction passes No. 4 sieve	Clean Sands: Less than 5% fines ^D	$Cu \geq 6$ and $1 \leq Cc \leq 3$ ^E	SW	Well-graded sand ^I	
			$Cu < 6$ and/or $[Cc < 1$ or $Cc > 3.0]$ ^E	SP	Poorly graded sand ^I	
		Sands with Fines: More than 12% fines ^D	Fines classify as ML or MH	SM	Silty sand ^{G, H, I}	
			Fines classify as CL or CH	SC	Clayey sand ^{G, H, I}	
Fine-Grained Soils: 50% or more passes the No. 200 sieve	Silts and Clays: Liquid limit less than 50	Inorganic:	$PI > 7$ and plots on or above “A”	CL	Lean clay ^{K, L, M}	
			$PI < 4$ or plots below “A” line ^J	ML	Silt ^{K, L, M}	
		Organic:	Liquid limit - oven dried	< 0.75	OL	Organic clay ^{K, L, M, N}
			Liquid limit - not dried			Organic silt ^{K, L, M, O}
	Silts and Clays: Liquid limit 50 or more	Inorganic:	PI plots on or above “A” line	CH	Fat clay ^{K, L, M}	
			PI plots below “A” line	MH	Elastic Silt ^{K, L, M}	
		Organic:	Liquid limit - oven dried	< 0.75	OH	Organic clay ^{K, L, M, P}
			Liquid limit - not dried			Organic silt ^{K, L, M, Q}
Highly organic soils:	Primarily organic matter, dark in color, and organic odor			PT	Peat	

^A Based on the material passing the 3-inch (75-mm) sieve.

^B If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.

^C Gravels with 5 to 12% fines require dual symbols: GW-GM well-graded gravel with silt, GW-GC well-graded gravel with clay, GP-GM poorly graded gravel with silt, GP-GC poorly graded gravel with clay.

^D Sands with 5 to 12% fines require dual symbols: SW-SM well-graded sand with silt, SW-SC well-graded sand with clay, SP-SM poorly graded sand with silt, SP-SC poorly graded sand with clay.

$$E \quad Cu = D_{60}/D_{10} \quad Cc = \frac{(D_{30})^2}{D_{10} \times D_{60}}$$

^F If soil contains $\geq 15\%$ sand, add "with sand" to group name.

^G If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.

^H If fines are organic, add "with organic fines" to group name.

^I If soil contains $\geq 15\%$ gravel, add "with gravel" to group name.

^J If Atterberg limits plot in shaded area, soil is a CL-ML, silty clay.

^K If soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel," whichever is predominant.

^L If soil contains $\geq 30\%$ plus No. 200 predominantly sand, add "sandy" to group name.

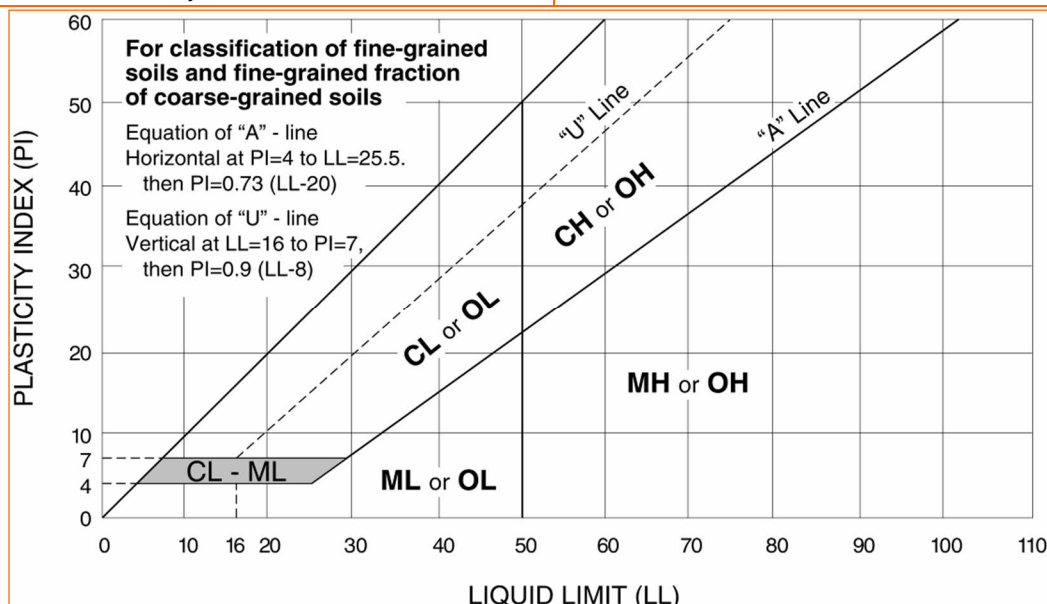
^M If soil contains $\geq 30\%$ plus No. 200, predominantly gravel, add "gravelly" to group name.

^N $PI \geq 4$ and plots on or above "A" line.

^O $PI < 4$ or plots below "A" line.

^P PI plots on or above "A" line.

^Q PI plots below "A" line.



APPENDIX E

Geotechnical Investigation

Proposed Four-Plex Mammoth Hot Springs

D-547

IN
STORAGE

B89-011 GEOTECHNICAL INVESTIGATION
Proposed Four-Plex
Mammoth Hot Springs
Yellowstone National Park, WY
PO #PX 1570-9-0629

NATIONAL PARK SERVICE

February 22, 1989

PLEASE RETURN TO:
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B&W Scans

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P.O. Box 6190, Bozeman, MT 59771-6190 — 406 / 587-9410

February 22, 1989

Consulting Soils and
Materials Engineers

J.S. BRAUN, P.E., President
P.H. ANDERSON, Vice President
C.G. KRUSE, P.E., Vice President
B.M. THORSON, P.E. Vice Pres./Area Engr.

National Park Service (6)
Attn: Mr. Tim Hudson
P.O. Box 168
Yellowstone National Park, WY 82190

Re: B89-011 GEOTECHNICAL INVESTIGATION
Proposed Four-Plex
Mammoth Hot Springs
Yellowstone National Park, WY
PO #PX 1570-9-0629

Dear Mr. Hudson:

The geotechnical investigation requested by Mr. Ray Shriver on January 23, 1989 has been completed. The purpose of the investigation was to assist in evaluating subsurface soil, rock and groundwater conditions related to design and construction of foundations, floors and earthwork for the proposed building. The investigation was completed in general accordance with our proposal to Mr. Shriver dated January 23, 1989.

Four penetration borings were completed in the proposed building area. The general soil profile was 2 inches of topsoil underlain by loose to dense alluvial deposits over medium to hard glacial till and travertine. Groundwater was encountered at depths ranging from 8.3 to 14.8 feet.

It is our opinion that the site is suitable for the proposed building and that it can be supported on shallow spread footings designed for a net allowable bearing pressure up to 1500 psf. Surface compaction of the footing subgrades is recommended. Our laboratory tests and calculations indicate that total and differential settlement will not exceed 3/4 inch. The proposed basement floor may be supported on undisturbed natural soils or compacted fill. A perimeter foundation drain system and good drainage away from the building is recommended.

Environmental Testing & Consulting Services Affiliate — Braun Environmental Laboratories, Inc.

Affiliated Offices: Minnesota — Minneapolis — Hibbing — St. Cloud — Rochester — St. Paul
North Dakota — Williston — Bismarck
Illinois — Chicago

February 22, 1989

Please refer to the attached report for more detailed results of our investigation, engineering analysis and recommendations. If we can be of further assistance, please contact us at your convenience.

Very truly yours,

BRAUN ENGINEERING TESTING
OF MONTANA, INC.

Gregory T. Staffileno

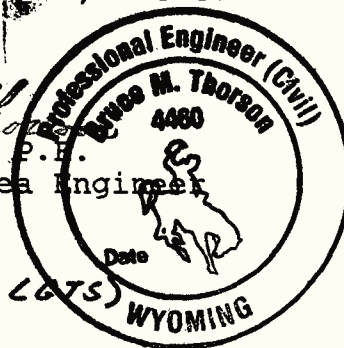
Gregory T. Staffileno, E.I.T.
Project Engineer

Bruce M. Thorson

Bruce M. Thorson, P.E.
Vice President/Area Engineer

C. G. Kruse

C.G. Kruse, P.E.
Vice President



GTS/BMT/CGK:al

cy: Braun Engineering Testing, Inc.

Encl: Engineering Report
Site Location Sketch
Boring Location Sketch
Logs ST-1 through ST-4
Swell Test
Descriptive Terminology

B89-011 GEOTECHNICAL INVESTIGATION
Proposed Four-Plex
Mammoth Hot Springs
Yellowstone National Park, WY

A. SCOPE AND PROCEDURES:

A.1. Purpose: The purpose of the investigation was to assist in evaluating subsurface soil and groundwater conditions related to design and construction of foundations, floors and earthwork for the proposed building.

A.2. Scope: The investigation consisted of four penetration test borings to depths ranging from 13 to 25 1/2 feet in the proposed building area. Several unsuccessful attempts were made to obtain a California tube sample of the silty sand alluvium. A California tube sample of the underlying clay till was obtained for a consolidation/swell test. The samples were returned to our laboratory and visually classified and logged by a geotechnical engineer. A swell test was conducted on the California tube sample. The results were analysed and discussed with Mr. Tim Hudson. This engineering report was then prepared.

The design of pavement sections was not included in our scope of services.

A.3. Boring Locations and Elevations: Boring locations were selected by National Park Service personnel. The locations are shown on the attached Boring Location Sketch. Boring ST-1 had to

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be moved 16 feet east because of a rather sharp slope and utility lines running through the site to satellite dishes.

Ground surface elevations were also determined by National Park Service personnel. After Boring ST-1 was moved, the new ground surface elevation was determined from the known elevation of the original location by our personnel.

A.4. Field Testing and Sampling: The penetration test borings were performed on February 9 and 10, 1989, with a truck-mounted core and auger drill. Sampling for the borings was conducted in accordance with ASTM D1586, "Penetration Test and Split-Barrel Sampling of Soils." Using this method, we advanced the bore hole with hollow-stem auger to the desired test depth. Then a 140-pound hammer falling 30 inches drove a standard, 2-inch OD, split-barrel sampler a total penetration of 1 1/2 feet below the tip of the hollow-stem auger. The blows for the last foot of penetration were recorded and are an index of soil strength characteristics.

Three of the borings encountered very dense travertine. When the sampler could not be driven 6 inches with 50 blows of the hammer, the distance the sampler was advanced with 50 blows was recorded. When this situation occurred during the first 6 inches of the drive, it was noted as occurring within the "set".

February 22, 1989

A set of California tube samples were taken in the medium to hard clay till. The California sampler consists of a thick-walled tube with brass liner tubes. As the sampler is driven, soil enters the liner tubes. The tubes are then removed from the sampler, sealed at the ends and transported to the laboratory.

A.5. Soil Classification: Soils encountered in the borings were visually and manually classified in the field by the crew chief in accordance with ASTM D2487, "Unified Soils Classification System," and ASTM D2488, "Recommended Practice for Visual and Manual Description of Soils." A summary of ASTM D2487 is attached. All samples were then returned to the laboratory for a review of the field classifications by a geotechnical engineer. Representative samples will remain in our Billings office for a period of 60 days to be available for your examination.

A.6. Groundwater Measurements: About 10 minutes after taking the final sample in the bottom of a boring the bore hole was probed through the hollow-stem auger to check for the presence of groundwater. Immediately after withdrawal of the auger, the bore hole was again probed and the depth to water or cave-in was noted. The boring was then backfilled.

A.7. Laboratory Tests:

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February 22, 1989

A.7.a. Penetrometer Tests: Cohesive samples were tested with a pocket penetrometer to obtain an estimate of the unconfined compression strength. The pocket penetrometer test is conducted by slowly pushing a 0.25-inch diameter rod 1/4 inch into a sample with a calibrated spring. Compression of the spring has been correlated to unconfined compression strength by the manufacturer.

A.7.b. Swell Test: A swell test was conducted on the California tube sample from Boring ST-2. The test was conducted by placing a 1-inch thick specimen in a consolidation/swell machine and increasing the load in increments to 1070 psf. Each load was maintained for at least 8 hours prior to increasing the load. The specimen was inundated with water at a load of 520 psf and the swell observed prior to increasing the load. After the test the initial moisture content and dry density of the sample were determined.

B. RESULTS:

B.1. Logs: Log of Boring sheets indicating the depths and identifications of the various soil strata, the penetration resistances, laboratory test data and water level information are attached. It should be noted that the depths shown as boundaries between the strata are only approximate. The actual changes may

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be transitions and the depths of the changes likely vary horizontally.

B.2. Site Conditions: As the Site Location Sketch indicates, the site is located southeast of the Mammoth complex in the mountains. The site is also located downhill and to the east of the Hot Springs. The site slopes downward towards the south southeast with a slope of about 14%. General drainage in the area appears is towards the west. The variation in ground surface elevations at the borings was 6.8 feet. A 2-inch water line and two power lines cut across the proposed building area. The site was covered by snow at the time of our investigation.

The borings encountered 1 to 1 1/2 feet of frozen soils beneath the snow due to frost penetration. Frozen soils are stiffer than unfrozen soils and this resulted in relatively high penetration resistances near the surface. Consequently, the penetration test values from 1/2 to 1 1/2 feet indicated on the logs were not used to evaluate the strength characteristics of the soils near the surface.

B.3. Soils Encountered: Two inches of topsoil and root zone was encountered at the borings. Beneath the topsoil and root zone the general soil profile was alluvial deposits over glacial till and travertine. These strata are described in more detail below.

B.3.a. Alluvial Deposits: Alluvial deposits consisting of silty sand, sandy gravel and silty clay were encountered beneath the topsoil in all of the borings to depths ranging from 8 to 13 1/2 feet. These strata were possibly transported and deposited by water from the Hot Springs. Penetration resistances generally ranged from 5 to 9 blows per foot (BPF) indicating the alluvial deposits were generally loose. The sandy gravel and occasional partially cemented layers had higher penetration resistances.

B.3.b. Glacial Till: Glacial till consisting of sandy silty clay with a little gravel was encountered in Borings ST-1 and ST-2 beneath the alluvial deposits to depths ranging from 21 to 25 1/2 feet. Penetration resistances ranged from 7 to 42 BPF and pocket penetrometer strengths ranged from 3/4 to 2 1/4 tsf. These values indicated the glacial till was medium to hard.

B.3.c. Travertine: Travertine consisting of cemented silty sand was encountered in Borings ST-3 and ST-4 beneath the alluvial deposits and in Boring ST-1 beneath the glacial till. Penetration resistances ranged from 50 blows per 6 inches to 50 blows with no penetration. These values indicated the travertine was very dense. In Borings ST-3 and ST-4, drilling in the travertine was very difficult and the borings had to be terminated prior to

reaching the proposed 25-foot depth. They were advanced at least 3 feet into the travertine, however.

B.4. Groundwater Measurements: Groundwater was observed in three of the borings at depths ranging from 8.3 feet in Boring ST-4 to 14.8 feet in Boring ST-3. These depths corresponded to elevations ranging from 6052.5 to 6049.1. Groundwater was not encountered in Boring ST-2; several days may be required to obtain a stable level in a boring in clay (glacial till).

Seasonal and annual fluctuations of the groundwater table occur due to variations in rainfall, irrigation, snowmelt and other factors not evident at the time of the investigation. If the groundwater table rises more than 4 1/2 feet above its current level, it could affect the proposed building. Groundwater rarely fluctuates over 4 feet, however, and it appears that these fluctuations will not affect design, construction or performance of the proposed building.

B.5. Laboratory Tests:

B.5.a. Moisture Content: The moisture content of the California sample tested was 22.7%.

B.5.b. Dry Density: The dry density of the California sample tested was 102.9 pounds per cubic foot (pcf).

B.5.c. Swell Test: The result of the swell test performed on the California tube sample from Boring ST-2 is shown on the attached graph. The sample swelled less than 1% under a load of 520 psf after water was added. This is a relatively small value. The swell pressure was 1600 psf. This is also a relatively small value.

C. ANALYSIS AND RECOMMENDATIONS:

C.1. Available Information: It is our understanding that the proposed four-plex will be a two-story wood-frame building with a full basement. The site development drawing furnished to us indicates the proposed building has a rectangular-shaped floor plan about 2700 square feet in area. The finish floor elevation of the first floor is 6066.5. Foundations will be cast-in-place concrete. The basement floor will be an earth-supported concrete slab. The drawing indicates that a foundation drain with an invert elevation of 6056.6 will be placed around the basement. Assuming that the foundation drain will be placed at bottom-of-footing level, we have assumed that the finish floor elevation of the basement will be about 6057.5. We have assumed that the basement will be heated.

For the purpose of this report we have assumed that: 1) wall loads will be less than 5 kips per lineal foot, 2) column loads will be

less than 30 kips, 3) distributed floor loads will be less than 250 psf, and 4) concentrated floor loads will be less than 1000 pounds.

If the proposed loads or grades exceed these values, we should be informed. Additional analysis and recommendations may be necessary.

C.2. Discussion: The general soil profile encountered by the borings was topsoil underlain by loose alluvial deposits over medium to hard glacial till and very dense travertine. No caverns or voids were encountered by the borings. It is our opinion that conventional spread footings placed on undisturbed natural soils will adequately support the proposed building. However, we do recommend a very thorough inspection of footing subgrades and sidewalls of the basement excavation sidewalls to see if caverns or voids exist. If they do, additional investigation and analysis will be required.

We also wish to note that loose silty sand soils are potentially collapsible, i.e., they might consolidate excessively if they become wet or saturated. Providing good drainage for surface water will be particularly important at this site.

C.3. Foundations:

C.3.a. Depth: We recommend a minimum of 4 feet of earth cover over the bottoms of the exterior sides of perimeter footings for frost protection. Because of the full basement and the final grades selected, it appears that more than enough earth cover will be placed over perimeter footings for frost protection. Interior footings (if any) may be placed immediately beneath the basement slab.

C.3.b. Footing Subgrades: We recommend that footings bear on undisturbed natural soil or engineered backfill placed over undisturbed natural soils. If trench backfill for existing utility lines is present beneath proposed footings, we recommend that it be removed from beneath the proposed footings and an oversize zone extending 1/2 foot beyond the footings for every foot of subexcavation and replaced with engineered backfill.

Engineered backfill can be soils from the excavation placed in lifts not exceeding 8 inches uncompacted thickness. They should be moistened to a moisture content near or slightly above optimum and compacted to a minimum of 95% of the maximum dry density determined in accordance with ASTM Method of Test D698 (standard Proctor).

The silty sand at bottom-of-footing elevation in Borings ST-3 and ST-4 was loose. We recommend that silty sand subgrade soils be surface compacted with a minimum of 4 passes of a vibrating plate compactor having a weight of at least 100 pounds.

C.3.c. Bearing Pressure: It is our opinion that footings may be designed for a net allowable bearing pressure up to 1500 psf (fifteen hundred pounds per square foot). (Net allowable bearing pressure is defined as that bearing pressure in excess of the final minimum overburden pressure.)

C.3.d. Anticipated Settlement and Heave: We anticipate total and differential settlement and heave of foundations designed and placed as recommended above will be less than 3/4 inch under the assumed loads. Buildings of this type can generally tolerate movements of this magnitude.

C.3.e. Basement Walls:

C.3.e.1. Reinforcement: We recommend the equivalent of two #5 bars near the tops and two #5 bars near the bottoms of the basement walls to provide a grade beam action in the foundation walls and reduce the widths of cracks created by shrinkage and local settlement and heave. Additional reinforcement may be necessary to resist vertical and lateral loads.

C.3.e.2. Exterior Backfill: We recommend that backfill placed on the exterior sides of basement walls be compacted to a minimum of 90% of the standard Proctor maximum dry density in "green" areas. Backfill beneath proposed slabs and pavements should be compacted to a minimum of 95% of the standard Proctor maximum dry density. Soils from the basement excavations may be used. We recommend backfill be placed at a moisture content near or slightly above optimum. The walls should be braced and/or the first floor deck should be installed prior to backfilling and compaction.

C.3.e.3. Lateral Earth Pressure: The borings indicate that the majority of the soil from the basement excavation will be alluvial silty sand. For compacted silty sand backfill we recommend using an equivalent fluid pressure of 40 pounds per square foot (psf) per foot of depth for designing the basement walls. If imported sand and gravel is used as backfill against the basement walls, an equivalent fluid pressure of 25 to 30 psf may be used, depending on the friction angle of the material. (Twenty-five psf may be used for a crushed well-graded material, 30 psf for a pit-run material with rounded particles.)

C.3.e.4. Seepage Control: The borings also indicated that in some areas the subgrade beneath the basement will be clay till.

If water percolates down alongside the walls, it may become perched on the clay layer and then enter the basement through shrinkage cracks in the concrete. Collecting roof runoff in gutters and discharging it well away from the foundations and sloping the ground surface down and away from the basement walls are two common methods of reducing infiltration and percolation. (In addition to preventing seepage into the basement, it is important that water not saturate the loose silty sand footing subgrade. Some loose silty sands "collapse" (consolidate excessively) if they become saturated.)

As a precaution against seepage and fluctuations of the groundwater table, we recommend installing a perimeter foundation drain system. As previously indicated, the site development drawing indicates a foundation drain will be installed. The system should include a perforated pipe with an invert within 2 inches of bottom-of-footing elevation. It should also include permeable material against the wall, such as a synthetic wall drainage system or 2 feet (horizontal) of permeable sand or sand and gravel. (Sand or sand and gravel with less than 5% of the particles by weight passing a #200 sieve is generally sufficiently permeable.) Collected seepage should be routed to a sump and pump or a storm sewer.

We recommend that the permeable exterior backfill be capped with a minimum of 1 foot of clay and topsoil. This cap will assist in providing runoff away from the building, reduce infiltration into the permeable backfill (silty sand or sandy gravel) and provide a better subsoil for topsoil and lawn. It may be necessary to import material for the clay cap. We recommend using clay with a plastic index between 7 and 25 and that it be moistened to a moisture content at or slightly above optimum moisture content when placed.

C.4. Basement Floor:

C.4.a. Subgrade: After the basement excavation, we anticipate the floor subgrade will be silty sand and clay till. We anticipate these soils will support the proposed floor slab without excessive settlement or heave.

C.4.b. Backfill: Some footing and utility trench backfill may be required beneath the proposed floor. On-site soils from the basement excavation may be used as backfill. We recommend they be moistened to a moisture content near or slightly above the optimum moisture content, then compacted to a minimum of 95% of the standard Proctor maximum dry density.

C.4.c. Vapor Barrier: If floor coverings less permeable than the concrete slab will be used, we recommend that a vapor barrier be placed beneath the slab.

C.5. Exterior Slabs:

C.5.a. Subgrade: The exterior slabs may be supported on undisturbed natural soils after the topsoil and root zone have been removed. Any fill beneath proposed slabs and their oversize zones should be placed at a moisture content near or slightly above optimum and compacted to a minimum of 95% of the standard Proctor maximum dry density.

C.5.b. Frost Protection: Silty sand and silty clay are moderately frost susceptible soils. If these soils become saturated and freeze, 1 to 2 inches of frost heave will likely result. Heaving of slabs during the winter can be a nuisance or hazard where doors open outward and at other critical grade areas.

One way to reduce this heave is to remove the frost susceptible silty sand and clay soils beneath the critical slabs to a depth of 5 feet below the slab and replace them with clean (non-frost susceptible) sand or sand and gravel. Sand or sand and gravel with less than 5% of the particles by weight passing a #200 sieve is generally considered non-frost susceptible.

Another method of reducing frost heave is to place a minimum of 2 inches of extruded polystyrene foam insulation beneath the slabs and extending about 4 feet beyond the slabs. Insulation will reduce frost penetration into the underlying subgrade and thereby reduce heave.

C.6 Exterior Drainage: We recommend a slope of at least 5% for the first 10 feet (or 10% for 5 feet) in "green" areas, then 2% to carry runoff away from the building. For slabs we recommend a minimum 2% slope away from the building. We recommend gutters, downspouts, and long splash blocks or conduits to carry runoff away from the building.

C.7. Utilities:

C.7.a. Materials: Silty sand, clay till and travertine deposits were encountered by the borings. Varying soil conditions are generally corrosive to metallic conduits. We recommend specifying non-corrosive materials or providing corrosion protection for utilities. It is our opinion that the soils excavated from the utility trenches will make a suitable bedding and backfill material for pipes.

C.7.b. Backfilling and Compaction: We recommend that bedding material be thoroughly compacted around the pipes. We recommend

that trench backfill above the bedding be compacted to a minimum of 90% in "green" areas and 95% beneath proposed footings, slabs and pavements.

C.8. Concrete: We recommend using cement meeting the requirements of ASTM C150 Type II to provide moderate resistance to sulfate attack. We recommend specifying 5 to 7% entrained air for exposed concrete to provide resistance to freeze-thaw deterioration. We recommend using a water/cement ratio of 0.50 or less for all exposed concrete and a water/cement ratio of 0.45 or less for concrete exposed to deicers.

D. CONSTRUCTION:

D.1. Excavation: It is our opinion that the soils encountered by the borings can be excavated with a backhoe, front end loader or scraper.

D.2. Observations: We recommend that footing subgrades and basement sidewalls be observed by a geotechnical engineer or an engineering technician under the direction of a geotechnical engineer to evaluate if the subgrade and sidewalls soils are similar to those encountered by the borings. The base sidewalls of the basement excavation should also be carefully observed for the presence

of caverns or voids. If caverns or voids are observed, additional investigation, analysis and recommendations will be necessary.

D.3. Testing: After the proposed basement has been excavated, we recommend that tests be conducted on the footing subgrades to evaluate if the bearing capacity is at least 1500 psf. Typical instruments used for these tests include hand augers, penetrometers and sample tubes.

We recommend density tests of fills and backfills placed beneath footings and slabs. We also recommend density tests on backfill placed next to foundation walls. We recommend slump, air content and strength tests on Portland cement concrete.

Samples of proposed backfill and fill materials should be submitted to a testing laboratory at least 3 days prior to placement on the site for evaluation and determination of the optimum moisture content and maximum dry density.

E. GENERAL REMARKS:

E.1. Basis of Recommendations: The analysis and recommendations submitted in this report are based upon four soil borings performed at the locations indicated on the attached sketch.

Variations may occur between these borings, the nature and extent

of which may not become evident until construction. If variations are encountered, it will be necessary to make a re-evaluation of the recommendations of this report after performing on-site observations during the construction and noting the characteristics of any variations. Such variations may result in additional foundation costs and it is suggested that a contingency be provided for this purpose.

To permit correlation of the soil data obtained to date with the actual soil conditions encountered during construction and to provide continuing professional responsibility for the conformance of the construction to the concepts originally contemplated in this report and to the plans and specifications, it is recommended that we be retained to develop and perform the necessary observation and testing program for the excavation and foundations phases of the project.

If others perform the recommended observations and/or testing of construction, professional responsibility becomes divided since in doing so, they assume responsibility for verifying that the soil conditions throughout the construction areas are similar to those encountered in the borings or recognizing variations which would require a change in recommendations.

E.2. Review of Plans and Specifications: This report is based on the preliminary design of the proposed structure as submitted to us for the preparation of this report. Because of the limited amount of information available, a number of assumptions were necessary to permit us to make recommendations. It is recommended that we be retained to review the final design and specifications to determine whether those assumptions were correct and whether any change in concept may have had any effect on the validity of our recommendations, and whether our recommendations have been implemented in the design and specifications. If we are not permitted to make this recommended review, we will not be liable for losses arising out of such design changes, or misinterpretation or misapplication of our recommendations.

E.3. Groundwater: Water level readings have been made in the borings at the times and under conditions stated on the boring logs. This data has been reviewed and interpretations made in the text of this report. However, it must be noted that the period of observation was relatively short and that fluctuations in the level of the groundwater may occur due to variations in rainfall, temperature, irrigation, pumping, snowmelt and other factors not evident at the time measurements were made and reported herein. Design drawings and specifications and construction planning should recognize the possibilities of variations.

February 22, 1989

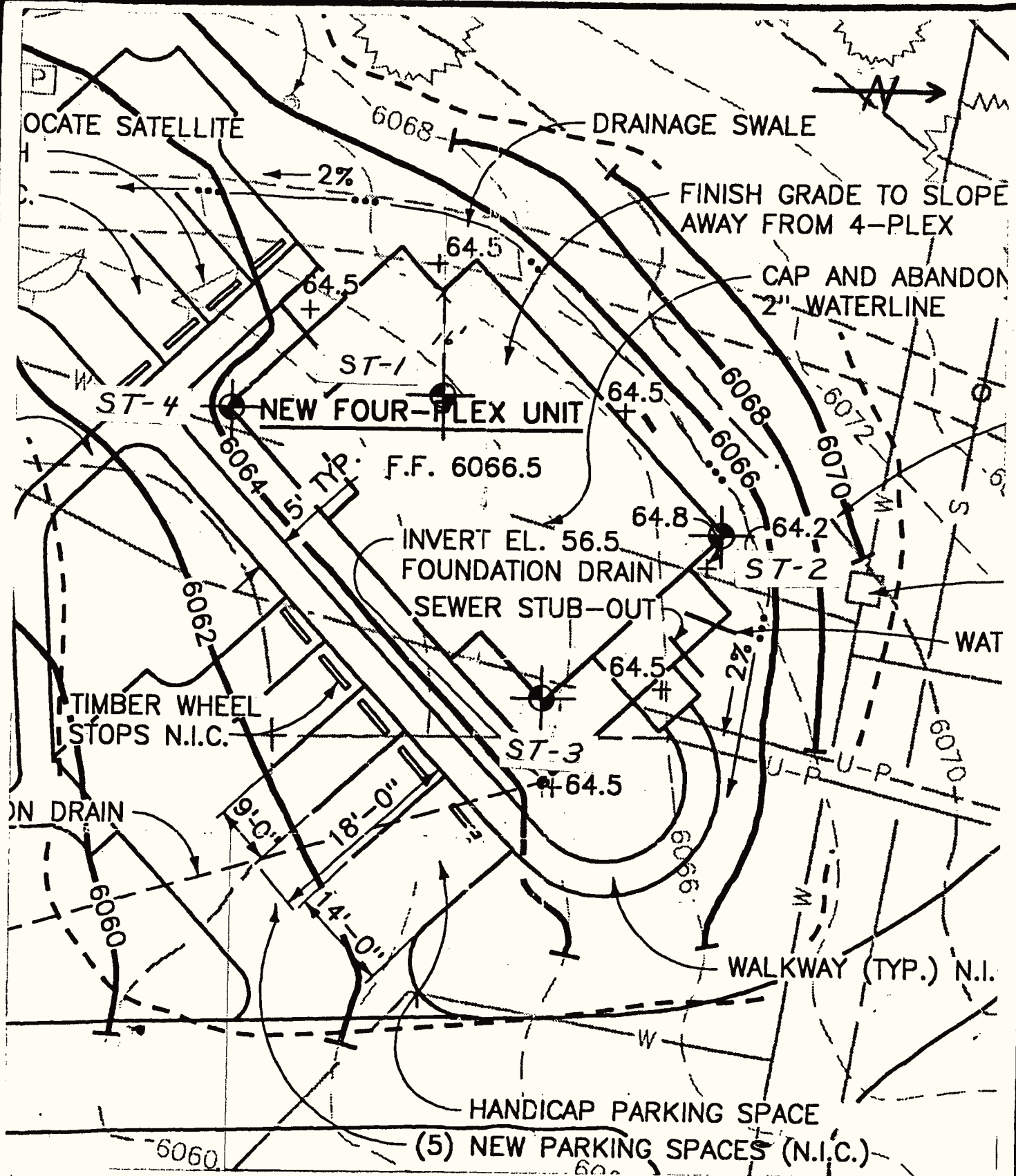
E.4. Standard of Care: Services performed by the geotechnical engineers for this project have been conducted in a manner consistent with that level of care and skill ordinarily exercised by members of the profession currently practicing in this area under similar budget and time restraints. This is our professional responsibility. No warranty, expressed or implied, is made.

E.5. Professional Certification: I hereby certify that this report was prepared by me or under my direct supervision and that I am a duly Registered Professional Engineer under the laws of the State of Wyoming.



Bruce M. Thorson, P.E.
Registration Number 4460
Date: February 22, 1989





BORING LOCATION SKETCH

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B89-011 GEOTECHNICAL INVESTIGATION
 Proposed Four-Plex
 Mammoth Hot Springs
 Yellowstone National Park, WY

Date: 2/14/89

Revised: GIS

Drawn: Client

Scale: 1"=20'

LOG OF BORING

BRAUN
ENGINEERING TESTING

PROJECT: 889-011 GEOTECHNICAL INVESTIGATION
Proposed Four-Plex
Mammoth Hot Springs
Yellowstone National Park, WY

BORING: ST-1

LOCATION:

See Boring Location Sketch

DATE: 2/10/89

SCALE: 1"=4'

(See Report and Standard Plates for evaluation and descriptive terminology.)

Elev. 6063.6	Depth 0.0	ASTM D2487 Symbol	Description of Materials (ASTM D2488)	BPF	WL	Tests or Notes
6062.6	1	SM-SC SM	2" of Topsoil and root zone over SILTY SAND, <u>fine grained, non to slightly *</u> SILTY SAND, fine grained, nonplastic, trace gravel, white to brown, moist, loose to medium dense. (alluvium)	23/14		frozen to 1 1/2'
				1/6		
				1/4		
6056.1	1 1/2	GP-GM	SANDY GRAVEL, fine to coarse grained, trace silt, pale brown, moist to water-bearing, medium dense to very dense. (alluvium)	13/50		
				22		
6050.1	13 1/2	CL	SANDY SILTY CLAY, low to medium plasticity, trace gravel & humus, reddish brown, saturated, rather stiff to very stiff. (till)	29/50	for 3"	qp*=3/4
				12		
6042.6	21	SM	TRAVERTINE (Soil Class: Silty Sand, fine to coarse grained, nonplastic, cemented, white, waterbearing, very dense.)	20		qp=3/4
6038.6	25			50	for 6"	
			END OF BORING			
			*plastic, trace roots, dark brown, moist. (alluvium)			*qp=pocket penetrometer estimate of unconfined compressive strength, tons per square foot.
			Water level down 20 1/2' with 24' of hollow-stem auger in the ground.			
			Water level down 11' immediately after withdrawal of auger.			

LOG OF BORING

BRAUN
ENGINEERING TESTING

PROJECT: B89-011 GEOTECHNICAL INVESTIGATION
Proposed Four-Plex
Mammoth Hot Springs
Yellowstone National Park, WY

BORING: ST 2

LOCATION:

See Boring Location Sketch

DATE: 2/9/89

SCALE: 1"=4'

Elev.	Depth	ASTM D2487 Symbol	Description of Materials (ASTM D2488)	BPF	WL	Tests or Notes
6067.8	0.0					
6066.3	1½	CL	2" of Topsoil and root zone over SILTY CLAY, low plasticity, trace roots and salts, dark brown, dry. (fine alluvium)	26/17		frozen to 1½'
		SM-SC	SILTY SAND, fine to medium grained, slightly plastic, trace fine gravel, roots and salts, brown, dry, medium dense.*	13		
6064.3	3½	SM	SILTY SAND, fine to coarse grained, non-plastic, trace gravel, white to brown, moist, loose to medium dense.(alluvium)	6		
				20		
				7		
6056.8	11					
		CL	SANDY SILTY CLAY, low to medium plasticity, trace gravel, brown, moist, medium to hard. (till)	7		qp=1¼
				13		qp=1 3/4
				CS**		
				27		qp=2¼
6042.3	25½			42		qp=2
			END OF BORING			
			Water level not encountered with 24' of hollow-stem auger in the ground.			
			Water level not encountered to dry cave-in depth of 18' immediately after withdrawal of auger.			
			*(alluvium)			**California tube sample, See Section A.4 of report.

(See Report and Standard Plates for evaluation and descriptive terminology.)

LOG OF BORING



PROJECT: 889-011 GEOTECHNICAL INVESTIGATION
Proposed Four-Plex
Mammoth Hot Springs
Yellowstone National Park, WY

BORING: ST-3

LOCATION:

See Boring Location Sketch

DATE: 2/9/89

SCALE: 1"=4'

(See Report and Standard Plates for evaluation and descriptive terminology.)

Elev.	Depth	ASTM D2487 Symbol	Description of Materials (ASTM D2488)	BPF	WL	Tests or Notes
6063.9	0.0					
6061.4	2½	SM-SC	2" of Topsoil and root zone over SILTY SAND, fine grained, slightly plastic, trace roots and fine gravel, light olive brown, dry, loose. (alluvium)	16		frozen to 1'
6060.4	3½	SP	SAND, fine grained, nonplastic, trace fine gravel, white, dry, loose. (alluvium)	4/5		
		SM	SILTY SAND, fine to coarse grained, nonplastic, trace gravel, white to brown, moist, dense to loose. (alluvium)	33		
			seam of clayey silt @ 7½'	8		
				9		
6050.4	13½			9		
6047.5	16½		TRAVERTINE (Soil Class: Silty Sand, fine to coarse grained, nonplastic, cemented, white, wet to waterbearing, very dense.)	50	for D"(set)	
			VERY DIFFICULT DRILLING, boring terminated.			
			Water level down 14.8' with 16½' of hollow-stem auger in the ground.			
			Water level not encountered to dry cave-in depth of 12.6' immediately after withdrawal of auger.			

LOG OF BORING



PROJECT: 889-011 GEOTECHNICAL INVESTIGATION
Proposed Four-Plex
Mammoth Hot Springs
Yellowstone National Park, WY

BORING: ST-4

LOCATION:

See Boring Location Sketch

DATE: 2/9/89

SCALE: 1"=4'

Elev.	Depth	ASTM D2487 Symbol	Description of Materials (ASTM D2488)	BPF	WL	Tests or Notes
6061.0	0.0					
6059.5	1½	SM-SC	2" OF Topsoil and root zone over SILTY SAND, fine grained, slightly plastic,*	15/7		frozen to 1½'
		SM	SILTY SAND, fine to medium grained, nonplastic, trace salts & gravels, brown to white, moist, loose. (alluvium)	6		
				5		
				8		
6053.0	8					
		SM	TRAVERTINE (Soil Class: Silty Sand, fine to coarse grained, nonplastic, cemented, white, waterbearing, very dense.)	50 for 1"	▼	(set)
6048.0	13			50 for 0"		(set)
			VERY DIFFICULT DRILLING, boring terminated.	50 for 0"		(set)
			*trace roots and salts, dark brown mottled white, moist. (alluvium)			
			Water level down 9.5' with 13' of hollow-stem auger in the ground.			
			Water level down 8.3' immediately after withdrawal of auger.			

(See Report and Standard Plates for evaluation and descriptive terminology.)

SWELL TEST
UNIT STRAIN VS. LOG PRESSURE CURVE

Project: B89-011 Proposed Four-Plex

Date: 2/13/89

Soil Description: SANDY SILTY CLAY, fine to coarse grained, low to medium plasticity, trace gravel, reddish brown, moist (CL)

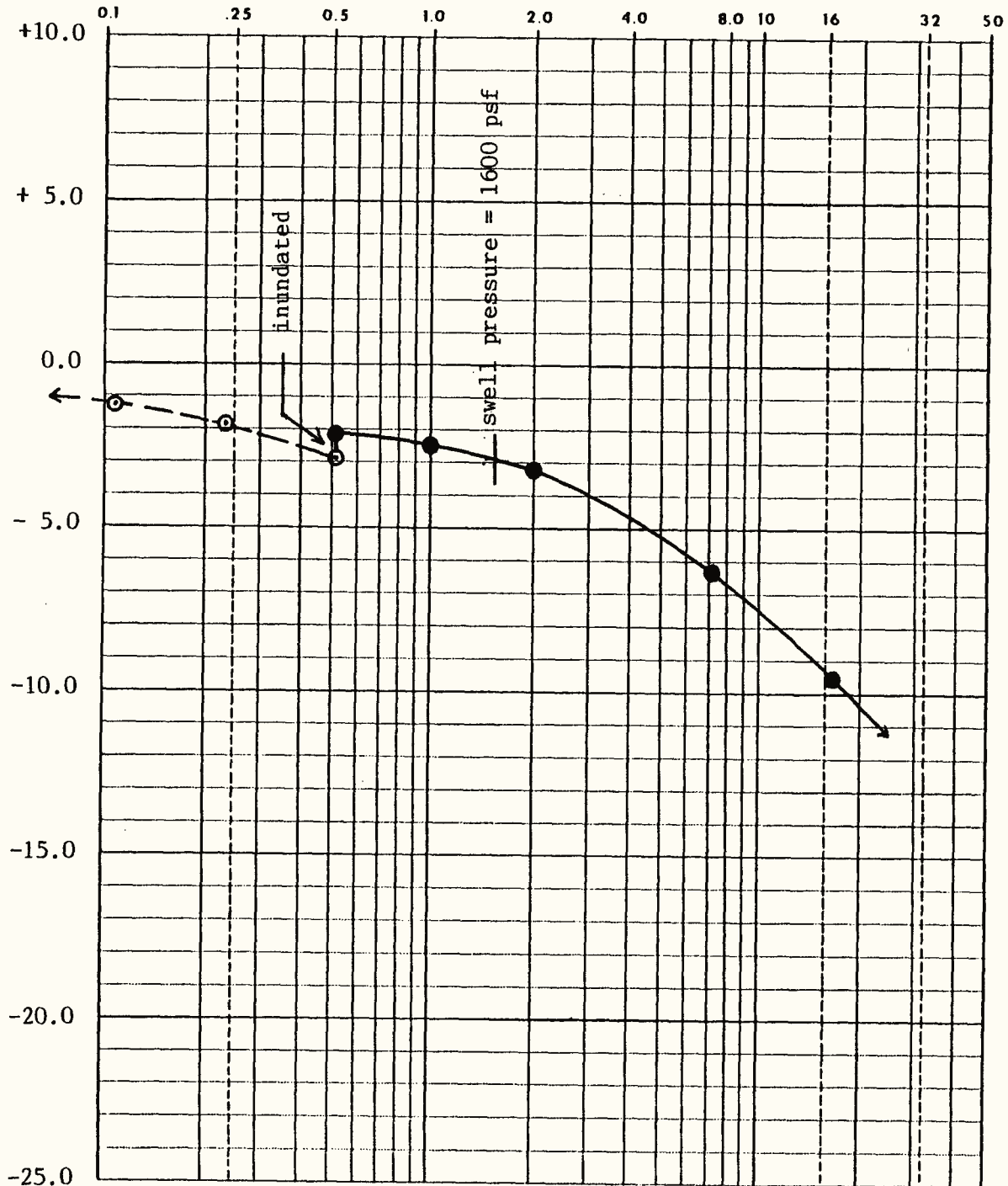
Boring: ST-2

Sample: C.S.

Depth: 17-18'

LL= -- %, MC= 22.7%, PL= -- % Dry Unit Wt.=102.9 pcf

Vertical Pressure, kips/sq. ft.



Descriptive Terminology

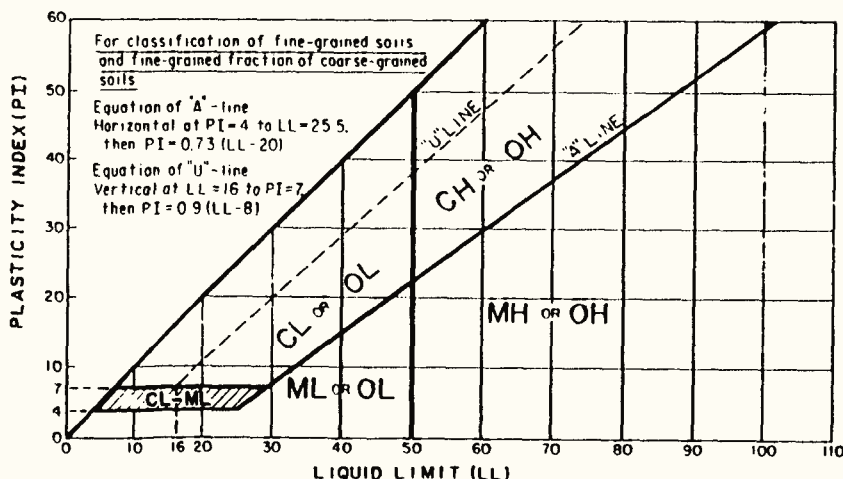


Designation D 2487 — 83

Standard Test Method for CLASSIFICATION OF SOILS FOR ENGINEERING PURPOSES

CRITERIA FOR ASSIGNING GROUP SYMBOLS AND GROUP NAMES USING LABORATORY TESTS ^a				SOIL CLASSIFICATION	
				GROUP SYMBOL	GROUP NAME ^b
COARSE-GRAINED SOILS more than 50% retained on No. 200 sieve	GRAVELS More than 50% of coarse fraction retained on No. 4 sieve	CLEAN GRAVELS Less than 5% fines ^c	$C_u \geq 4$ and $1 \leq C_c \leq 3$ ^e	GW	Well-graded gravel ^f
			$C_u < 4$ and/or $1 > C_c > 3$ ^e	GP	Poorly graded gravel ^f
	SANDS 50% or more of coarse fraction passes No. 4 sieve	GRAVELS WITH FINES More than 12% fines ^c	Fines classify as ML or MH	GM	Silty gravel ^{f,g,h}
			Fines classify as CL or CH	GC	Clayey gravel ^{f,g,h}
		CLEAN SANDS Less than 5% fines ^d	$C_u \geq 6$ and $1 \leq C_c \leq 3$ ^e	SW	Well-graded sand ⁱ
			$C_u < 6$ and/or $1 > C_c > 3$ ^e	SP	Poorly graded sand ⁱ
FINE-GRAINED SOILS 50% or more passed the No. 200 sieve	SILTS AND CLAYS Liquid limit less than 50%	Inorganic	PI > 7 and plots on or above "A" line J	CL	Lean clay ^{k,l,m}
			PI < 4 or plots below "A" line J	ML	Silt ^{k,l,m}
		Organic	Liquid limit - oven dried Liquid limit - not dried < 0.75	OL	Organic clay ^{k, l, m, n} Organic silt ^{k, l, m, o}
				CH	Fat clay ^{k,l,m}
	SILTS AND CLAYS Liquid limit 50% or more	Inorganic	PI plots on or above "A" line	CH	Fat clay ^{k,l,m}
			PI plots below "A" line	MH	Elastic silt ^{k,l,m}
		Organic	Liquid limit - oven dried Liquid limit - not dried < 0.75	OH	Organic clay ^{k, l, m, p} Organic silt ^{k, l, m, q}
				PT	Peat
Highly organic soils		Primarily organic matter, dark in color, and organic odor		PT	Peat

- a. Based on the material passing the 3-in (75-mm) sieve.
b. If field sample contained cobbles and/or boulders, add "with cobbles and/or boulders" to group name.
c. Gravels with 5 to 12% fines require dual symbols:
GM-GM well graded gravel with silt
GM-GC well graded gravel with clay
GP-GM poorly graded gravel with silt
GP-GC poorly graded gravel with clay
d. Sands with 5 to 12% fines require dual symbols:
SW-SM well graded sand with silt
SW-SC well graded sand with clay
SP-SM poorly graded sand with silt
SP-SC poorly graded sand with clay
e. $C_u = D_{60}/D_{10}$ $C_c = \frac{D_{30}^2}{D_{10} \times D_{60}}$
f. If soil contains $> 15\%$ sand, add "with sand" to group name.
g. If fines classify as CL-MH, use dual symbol GC-GM, SC-SM.
h. If fines are organic, add "with organic fines" to group name.
i. If soil contains $> 15\%$ gravel, add "with gravel" to group name.
j. If Atterberg limits plot in hatched area, soil is a CL-MH, silty clay.
k. If soil contains 35 to 29% plus No. 200, add "with sand" or "with gravel" whichever is predominant.
l. If soil contains $> 30\%$ plus No. 200, predominantly sand, add "sandy" to group name.
m. If soil contains $> 30\%$ plus No. 200, predominantly gravel, add "gravelly" to group name.
n. PI > 4 and plots on or above "A" line.
o. PI < 4 or plots below "A" line.
p. PI plots on or above "A" line.
q. PI plots below "A" line.



LABORATORY TESTS

DD	Dry Density, pcf	OC	Organic Content, %
WD	Wet Density, pcf	S	Percent of Saturation, %
MC	Natural Moisture Content, %	SG	Specific Gravity
LL	Liquid Limit, %	C	Cohesion
PL	Plastic Limit, %	ϕ	Angle of Internal Friction
PI	Plasticity Index, %	qu	Unconfined Compressive Strength

PARTICLE SIZE IDENTIFICATION

Boulders	over 12"
Cobbles	3" to 12"
Gravel	
Coarse	3/4" — 3"
Fine	No. 4 — 3/4"
Sand	
Coarse	No. 4 — No. 10
Medium	No. 10 — No. 40
Fine	No. 40 — No. 200
Silt	No. 200 — .005 mm
Clay	less than .005 mm

RELATIVE DENSITY OF COHESIONLESS SOILS

very loose	0 — 4 BPF
loose	5 — 10 BPF
medium dense	11 — 30 BPF
dense	31 — 50 BPF
very dense	50+ BPF

CONSISTENCY OF COHESIVE SOILS

very soft	0 — 1 BPF
soft	2 — 3 BPF
rather soft	4 — 5 BPF
medium	6 — 8 BPF
rather stiff	9 — 12 BPF
stiff	13 — 16 BPF
very stiff	17 — 30 BPF
hard	30+ BPF

DRILLING NOTES

Standard penetration test borings were advanced by 3/4" or 6 1/4" I.D. hollow-stem augers unless noted otherwise. Jetting water was used to clean out auger prior to sampling only where indicated on logs. Standard penetration test borings are designated by the prefix "ST" (Split Tube).

Power auger borings were advanced by 4" or 6" diameter, continuous-flite, solid stem augers. Soil classification and strain depths are inferred from disturbed samples augered to the surface and are therefore somewhat approximate. Power auger borings are designated by the prefix "B".

Hand probings were advanced manually with a 1 1/2" diameter probe and are limited to the depth from which the probe can be manually withdrawn. Hand probings are indicated by the prefix "H".

SAMPLING — All samples are taken with the standard 2" O.D. split tube sampler, except where noted. TW indicates thin-wall (undisturbed) sample.

BPF — Numbers indicate blows per foot recorded in standard penetration test, also known as "N" value. The sampler is set 6" into undisturbed soil below the hollow-stem auger. Driving resistances are then counted for second and third 6" increments and added to get BPF. Where they differ significantly, they are reported in the following form — 2/12 for the second and third 6" increments respectively.

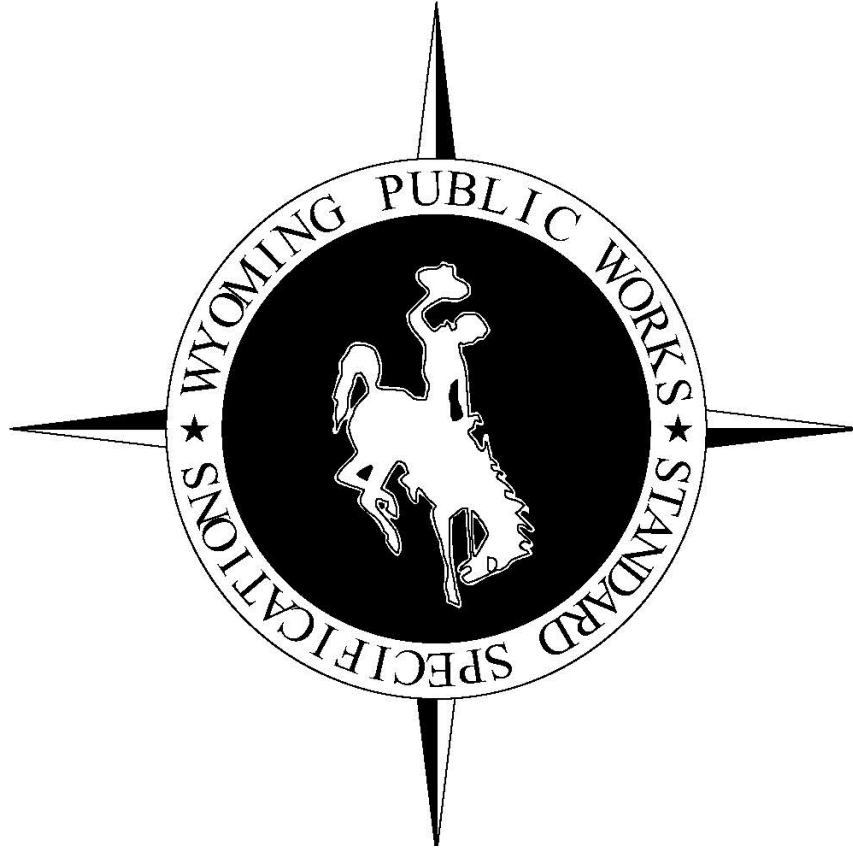
WH — WH indicates that sampler penetrated soil under weight of hammer and rods alone, driving not required.

NOTE — All tests run in accordance with applicable ASTM standards.

BRAUN™

APPENDIX F

Wyoming Public Works
Standard Specifications,
2023 Edition



WYOMING PUBLIC WORKS STANDARD SPECIFICATIONS

2023 EDITION

**The 2023 Edition of the Wyoming Public Works Standard
Specifications was prepared by the**

WYOMING PUBLIC WORKS COUNCIL



Wyoming Association
of Municipalities

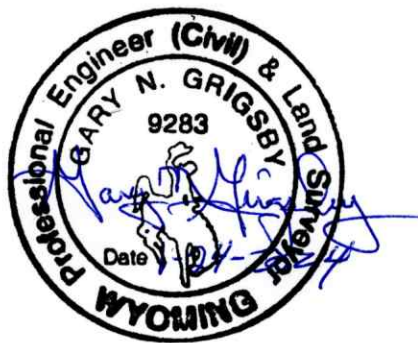


Wyoming County Commissioners Association



ACEC
AMERICAN COUNCIL OF ENGINEERING COMPANIES
of Wyoming

I, Gary N. Grigsby, hereby certify that I am the registered agent of the Wyoming Public Works Council that led a collaborative effort to prepare the 2023 Edition of the Wyoming Public Works Standard Specifications. My seal is placed on these standard specifications recognizing the following disclaimer.



Disclaimer: Users of the 2023 Edition of the Wyoming Public Works Standard Specifications hereby certify that they: 1) are duly licensed as a professional engineer in the State of Wyoming in accordance with Wyoming Statutes §33-29-201 through §33-29-801; 2) place their seal on the project manual wherein the standard specifications are incorporated by reference; 3) accept any and all liability resulting from their use of the standard specifications; and, 4) have made no alterations to the standard specifications except through Special Provisions included in the project manual.



Mark Gordon, Governor

Department of Environmental Quality

To protect, conserve and enhance the quality of Wyoming's environment for the benefit of current and future generations.



Todd Parfitt, Director

January 16, 2024

Wyoming Public Works Council
Gary Grigsby
1804 Laurel Drive
Cheyenne, WY 82001

RE: Wyoming Public Works 2023 Edition

Dear Mr. Grigsby,

Thank you for submitting the Wyoming Public Works 2023 Edition for review by the Wyoming Department of Environmental Quality, Water Quality Division (WQD). WQD staff have completed their review, and WQD concurs that the standards and specifications presented in the Wyoming Public Works 2023 Edition would meet the requirements for water and wastewater projects permitted by the WQD in accordance with Chapters 11 and 12 of the Wyoming Water Quality Rules.

As a reminder, entities electing to use the Wyoming Public Works 2023 Edition will still need to obtain all necessary permits from the Wyoming Department of Environmental Quality for their projects.

Thank you for the opportunity to review these standards and specifications. For additional comments or questions, please contact Keenan Hendon, Water and Wastewater Section Manager, at 307-777-7075 or keenan.hendon2@wyo.gov.

Best regards,

Jennifer Zygmunt
Administrator - Water Quality Division
Department of Environmental Quality

CC: Keenan Hendon, Water and Wastewater Section Manager

A GUIDE TO USING THE 2023 WYOMING PUBLIC WORKS STANDARD SPECIFICATIONS

GENERAL

In 1979, the Wyoming Association of Consulting Engineers and Surveyors (WACES) undertook a project to standardize the technical specifications and bidding documents for public works projects in the State of Wyoming. The set of specifications produced became known as the Wyoming Public Works Standard Specifications (WPWSS). The 2023 edition of the WPWSS represents the sixth edition of this important document. Authors of this edition include representatives of the American Council of Engineering Companies of Wyoming (ACEC of Wyoming), formerly known as WACES. Advisory support was provided by the Wyoming Department of Environmental Quality (WDEQ) and the Wyoming Department of Transportation (WYDOT).

This work was compiled and edited by the ACEC of Wyoming. This sixth edition incorporates the narrative format used by the Construction Specifications Institute (CSI), 1995 edition. The CSI format uses an outline style to describe scope of work, materials, execution of work, method of measurement and basis of payment. The CSI format provides a 16-division framework for the development of project specifications. Each division consists of a number of related sections. Division titles are fixed while section titles are assigned at the discretion of the author of the project manual.

The WPWSS represents the technical portion of the project manual. In addition to the WPWSS, the project manual generally contains the bidding requirements, contract forms, conditions of the contract, descriptions of modifications to both the standard conditions and specifications for the individual project, and references to the portions of the contract documents not bound into the project manual.

This edition of the WPWSS establishes a formal presentation of specifications which can be used in a variety of projects typical to the State of Wyoming. It is intended to be referenced in its entirety. Changes by individual users are to be made only through Special Provisions. The authors of these WPWSS recommend that the project manual incorporate documents issued by Engineer's Joint Contract Documents Committee (EJCDC) for the bidding requirements, contract forms, and conditions of contract portions. These portions of the project manual are not considered specifications and should be well coordinated between the Owner and the Owner's legal and insurance counselors. The EJCDC documents are issued and published jointly by the National Society of Professional Engineers, the American Council of Engineering Companies, the American Society of Civil Engineers, and the Construction Specifications Institute, and are endorsed by the Associated General Contractors of America.

The Wyoming Public Works Council intends that these specifications will be updated on an as-needed basis to reflect changes in engineering and construction practices and to publish errata. Interested parties who wish to present changes to these specifications should send comments to ACEC of Wyoming.

THE PROJECT MANUAL

The project manual should be outlined early in the preliminary design process. The outline should be flexible enough to include or exclude sections of the documents when such change may become necessary. Having the outline will help make some very important decisions. One such decision is the method of payment to the Contractor. Another is the clear definition of responsibility for quality control and payment for required testing. Suggestions for dealing with these issues are included in this guide as they appear in their respective sections. The outline should contain the source of each item. A suggested project manual outline is presented in the following table.

ITEM	COMMENT
Cover	Should include the Title, "Project Manual", Project Name, Engineer of Record, and owner.
Table of Contents	Commonly divided into Introductory Pages, Bidding Requirements, Contract Documents, and Specifications.
Advertisement for Bid	The advertisement must be published per State Statute.
Instructions to Bidders	Should include detailed information and requirements for preparing and submitting bids. Include method of preparation of bids, qualification of bids during and after the bid opening and general requirements specified by Wyoming State Statutes.
Bid Form	Should include bid items, statements that the bidder has examined the site and locality where work is to be performed, acceptance of all terms and conditions of the bidding requirement by the bidder, and that the bidder will enter into a contract with owner or forfeit a bid bond. The bid form shall contain places for signature of bidder as an individual, partnership or corporation.
Bid Bond Form	Use form provided by the EJCDC.
Agreement Form	Use form provided by the EJCDC.
Performance Bond Form	Use form provided by the EJCDC.
Payment Bond Form	Use form provided by the EJCDC.
General Conditions	Use form provided by the EJCDC.
Supplementary Conditions	Should provide revisions or additions to the General Conditions.
Specifications	Refer to the WPWSS and list the sections to be used (may reproduce in white the WPWSS sections that apply).
Special Provisions	Written modifications of the WPWSS, inclusion of other standard specifications by reference, or other project-specific specifications.

Dividing the project manual using colored sheets is up to the author of the manual. It does make section identification easier and helps keep specific changes of the standard technical specifications recognizable. Other variations are subject to the author's preference as applicable. Including WPWSS by reference only is preferred because it greatly reduces printing and handling costs.

STANDARD FORMS

In conjunction with the outline suggested above, it is advisable to bind into the project manual any forms or documents either added to or modified during the bidding process and up to the time an agreement is executed between the Owner and the Contractor, and any forms which will be used during construction. Forms typically bound into the project manual include: addenda, application for payment, and change order.

The author of the project manual should be aware numerous variations of standard forms and standard general conditions exist. Funding agencies of the federal government (the United States Department of Agriculture – Rural Development (USDA-RD), the Environmental Protection Agency (EPA), and the Housing and Urban Development (HUD), to name a few) all have slightly differing requirements reflected in their accepted construction contracts. In addition, engineering societies have developed standard forms and standard general conditions. The authors of project manuals should carefully compare the forms used with their own writing for cross-compatibility between each document. It is not emphasized enough that the bidding requirements and CSI Division I of the contract documents contain certain legal obligations between the Owner, Engineer, and Contractor. It is imperative that the Engineer know and understand the implications of these requirements. It is further emphasized that the Owner's legal counsel be required to review these documents prior to both their publication and the execution of an Agreement.

DECISIONS

Users of the WPWSS must understand the contents of the document. They must know which item specifications are applicable and can be used for their project, which item specifications are NOT applicable and may need to be deleted, and which item specifications are not addressed in the WPWSS and therefore need to be written or otherwise included. How the items are included, deleted, or written is decided during the outline stage. At that time, the author should also decide on both the method of measurement and basis of payment to the Contractor. A suggested Method of Measurement and Basis of Payment format has been included in the WPWSS. The author may choose other options by writing a paragraph in the Special Provisions covering that section of any item specification. Other decisions of a general nature will be discussed under the item to which they pertain.

Three basic decisions have to be made on any item specification used:

- A. which class of material or manufactured item is acceptable;
- B. decisions to change word(s), sentence(s), or paragraph(s) to new or different meanings; and,
- C. decision(s) to add or delete from a section for supplementary meaning.

CERTIFICATIONS

Project manuals incorporating the WPWSS are to be authored by individuals duly licensed as a professional engineer in the State of Wyoming in accordance with Wyoming Statutes §33-29-201 through §33-29-801, and the engineering seals of the authors are to be placed on the manual. Authors placing their seal on the project manual accept any and all liability resulting from their use of the standard specifications.

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SECTION 01601 — MOBILIZATION
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SECTION 02110 — CLEARING AND GRUBBING
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SECTION 02570 — ADJUSTING STREET FIXTURES

SECTION 02645 — FIRE HYDRANTS

SECTION 02665 — WATER DISTRIBUTION AND TRANSMISSION SYSTEMS

SECTION 02700 — SANITARY SEWER SYSTEMS

SECTION 02725 — STORM DRAINS AND CULVERTS

SECTION 02731 — PRESSURE SEWER LINES AND FORCE MAINS

SECTION 02776 — CONCRETE SIDEWALKS, DRIVEWAY APPROACHES, CURB TURN FILLETS, VALLEY GUTTERS AND MISCELLANEOUS NEW CONCRETE CONSTRUCTION

SECTION 02805 — RELOCATION STREET SIGNS, UTILITY POLES AND MAILBOXES

SECTION 02895 — ENGINEERING FABRIC

SECTION 02900 — LANDSCAPING

SECTION 02915 — UNIT PAVERS

SECTION 03100 — CONCRETE FRAMEWORK

SECTION 03200 — CONCRETE REINFORCEMENT

SECTION 03251 — EXPANSION AND CONTRACTION JOINTS

SECTION 03304 — PORTLAND CEMENT CONCRETE

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SECTION 03310 — CONCRETE WORK

SECTION 03345 — CONCRETE FINISHING

SECTION 03370 — CONCRETE CURING

SECTION 03480 — PRECAST CONCRETE UNITS

SECTION 03600 — GROUT

STANDARD DRAWINGS

02220-01	TYPICAL TRENCH DETAIL
02528-01	COMBINED CURB & GUTTER DETAILS
02645-01	TYPICAL HYDRANT INSTALLATION DETAIL
02645-02	WATER VALVE ADJUSTMENT DETAIL
02645-03	BLOW OFF VALVE DETAIL
02665-01	WATER SERVICE LINE DETAIL
02665-02	THRUST BLOCKING DETAILS

02665-03	MINIMUM THRUST BLOCK DIMENSIONS (1 OF 2)
02665-04	MINIMUM THRUST BLOCK DIMENSIONS (2 OF 2)
02700-01	STANDARD CONE MANHOLE DETAIL
02700-02	STANDARD FLATTOP MANHOLE DETAIL
02700-03	TYPICAL MANHOLE CHANNEL DETAILS
02700-04	SANITARY SEWER SERVICE LINE DETAIL
02700-05	MANHOLE COVER DETAIL/MANHOLE ADJUSTEMENT DETAIL
02700-06	STANDARD SEWER CLEANOUT DETAIL
02776-01	VALLEY GUTTER & CURB TURN DETAIL

SECTION 01010 — SUMMARY OF WORK

PART 1 GENERAL

1.01 SUMMARY

- A. Apply for, obtain, and pay for permits required to perform the work.
- B. Comply with applicable codes and regulations of authorities having jurisdiction.
- C. Field-verify dimensions indicated on drawings before fabricating or ordering materials. Do not scale drawings.
- D. Notify Owner of existing conditions differing from those indicated on the drawings. Verify the existence and location of underground utilities along the route of proposed work. Omission of an existing utility location on the Drawings is not to be considered as its nonexistence. Inclusion of existing utility locations on the Drawings is not to be considered as its definite location. Do not remove or alter existing utilities without prior written approval.
- E. Contract Documents are intended to provide the basis for proper completion of the work suitable for the intended use of Owner. Anything not expressly set forth but which is reasonably implied or necessary for proper performance of the project shall be included.
- F. Portions of the Contract Documents are written in the imperative mode. Except where specifically intended otherwise, the subject of all imperative statements is Contractor. For example, "Furnish..." means "Contractor shall furnish...", "Provide..." means "Contractor shall provide...".

END OF SECTION

SECTION 01041 — PROJECT COORDINATION

PART 1 GENERAL

1.01 SUMMARY

- A. Schedule a preconstruction conference to be held within 20 days of the Notice of Award. Contractor's assigned supervisory personnel shall attend this conference.
- B. Conduct all construction activities between the hours of 7:00 a.m. and 6:00 p.m., Monday through Friday, except for emergencies. No work will be allowed on Saturdays without Owner's permission, and no work, except for emergencies, will be allowed on Sundays.
- C. Water for use during construction will be obtained by Contractor at their expense. If they elect to obtain water from the public water utility, they will make all the arrangements, comply with their regulations, and pay all fees and charges.

1.02 COORDINATION WITH PUBLIC AND PRIVATE AGENCIES

- A. If other utility companies elect to repair or replace their lines in the project area, their crews will be permitted access to the area to accomplish their work.
- B. Contact all utility companies for location of their facilities. Call at least 48 hours prior to excavation.
- C. Contractor is responsible for dust control and shall provide all equipment and personnel necessary to meet the requirements of this responsibility. Contractor shall provide Engineer with the name(s) and telephone number(s) of the person(s) designated to maintain dust control during evenings and weekends. If this person cannot be contacted, Owner may use its equipment to correct a dust problem. In this case, Contractor shall pay all costs incurred by Owner.
- D. Do not park vehicles or equipment on private property without written permission from the property owner.
- E. Permit Coordination
 - 1. Engineer/Owner will secure the appropriate Wyoming Department of Environmental Quality (DEQ) permit(s) required for construction authorization, such as construction of new or modifications to existing Water Treatment Facilities, Water Distribution Systems, Wastewater Collection Systems and Wastewater Treatment Facilities. In many circumstances, this may be prior to advertising the proposed work, but shall be prior to issuing a Notice to Proceed to the Contractor. When a permit is required, Construction shall be per the DEQ permit.
 - 2. Contractor will be required to secure all DEQ/Water Quality Division (WQD) construction-specific related permits regarding their pursuing the Work. In

general, permit(s) are required for activities that may ultimately discharge water (or pollutants) to Waters of the State. Activities requiring a DEQ permit may include:

- a. Coverage under a Wyoming Pollution Discharge Elimination System (WYPDES) permit for small construction activities. This is required for construction activities disturbing at least one (1) acre, but less than five (5) acres that may potentially discharge storm water runoff or minor amounts of ground water from excavations and depressions on a permitted site. Coverage under the Small Construction General Permit (SCGP) does not (currently) require either a Notice of Intent or a permit fee provided that the General Permit requirements are met, and that work is performed in accordance with the site-specific Storm Water Pollution Prevention Plan (SWPPP). The SWPPP may include structural & non-structural Best Management Practices (BMPs) and a copy of the SWPPP shall be maintained at the construction site. Additionally, any requisite BMP maintenance log shall be maintained onsite and available for review should DEQ staff, or DEQ authorized agent, visit the site for inspection.
- b. Coverage under a Wyoming Pollution Discharge Elimination System (WYPDES) Large Construction General Permit (LCGP). This is required for disturbances of five (5) or more acres or for disturbances of smaller sites that are part of a “Common Plan of Development or Sale” with a total disturbance of five (5) or more acres. The five acre disturbance need not be contiguous. Coverage under the LCGP requires Contractor to complete a Storm Water Pollution Prevention Plan (SWPPP), file a Notice of Intent (NOI) with DEQ, and pay any requisite permit fees. Coverage under the LCGP will begin when the Permit Authorization is posted to the DEQ website. Permit fees are to be paid with the NOI for the entire permit term.
- c. Coverage under a non-storm water permit, such as for the temporary discharge of ground water generated by trench dewatering operations, discharge of chlorinated water used for system disinfection, or discharge of water produced from hydrostatic pipeline testing. Contractor shall be responsible for completing and submitting a “Notice of Intent” (NOI) to DEQ. The DEQ will review the NOI and determine if the proposed activity is eligible for coverage under this permit or if the activity must be covered under an individual permit. If the proposed activity is eligible for coverage under the general permit, the DEQ will send Contractor an authorization letter. The authorization to discharge under a general permit will include effluent limitations and monitoring requirements deemed necessary to protect the surface waters of the State.

** Note that the Temporary Discharge Permit is a single permit that may cover all three (3) activities stated above but must be indicated as such and one (1) fee covers all permit activities.

3. For Temporary Discharge Permits, Contractor shall be solely responsible for performing any effluent water quality tests and all monitoring requirements imposed with the Notice of Authorization.
4. The contractor shall be considered the Responsible Party for the Site until they submit a "Notice of Termination" or "Notice of Transfer and Acceptance" to DEQ. If the site has not achieved stabilization prior to Final Acceptance, Contractor may file a Notice of Transfer and Acceptance with DEQ to transfer all permit requirements to the Owner, who shall then be responsible for the Site. Terms of responsibility and when a Notice of Transfer and Acceptance shall be as set forth in the Special Provisions, however, responsibility shall generally be the responsibility of the entity in "day-to-day control and supervision" of the Site.
5. The Permittee of Record with DEQ (Contractor or Owner) shall be solely responsible for maintaining all BMPs, conforming to any conditions adopted under his/her SWPPP throughout construction.
6. Filing of a Notice of Termination does not relieve Contractor (or Owner) of the obligations of the Permit until the permit is closed out by DEQ. DEQ may require verification of BMP removal (if appropriate) and site stabilization prior to ending coverage and permit obligations.
7. If the project is a new facility, where construction will create a new discharge point (permanent discharge or intermittent), then Owner shall be responsible for securing an appropriate WYPDES permit for ongoing operations at the time of construction completion.
8. If the project modifies an existing discharge location, either by changing the physical location or changing the effluent quantity or quality, then Owner shall be responsible for coordinating with DEQ WYPDES staff for permit modification. This coordination shall take place prior to effecting the discharge change but should not be considered cause for extension of contract time between Owner and Contractor nor cause for delay in accepting either substantial completion or final completion of the Work.

1.03

COORDINATION WITH OWNER AND ENGINEER

- A. Owner will provide engineering surveys to establish reference points as necessary. Construct all work in accordance with the lines and grades shown on the Drawings, and as designated by Engineer. These lines and grades may be modified by Engineer as provided in the General Conditions. Notify Engineer a minimum of 24 hours in advance to request surveying. All survey work shall be done by or under the direct supervision of a licensed Wyoming professional land surveyor.
- B. Unless otherwise provided for in the Contract, Owner shall employ and pay for the services of an independent testing laboratory to perform all tests required by the

Contract Documents. Notify Engineer a minimum of 24 hours in advance to request testing.

END OF SECTION

SECTION 01090 — REFERENCES

PART 2 GENERAL

1.01 COORDINATION OF CONTRACT DOCUMENTS

- A. The various portions of the Contract Documents, of which these specifications are a part, are essential parts of the Agreement, and a requirement occurring in any portion or part is as binding as though occurring in all. All portions are intended to be complementary and to describe and provide for a complete work. In case of discrepancy, the following hierarchy shall be observed:
 - 1. Special Provisions will govern over,
 - 2. Project Drawings, which will govern over,
 - 3. Supplementary Specifications, which will govern over,
 - 4. These specifications and Standard Drawings.
- B. Contractor shall not take advantage of any apparent error or omission in the Contract Documents. If Contractor discovers an error or omission, Contractor shall immediately notify Engineer. Engineer will pursue such corrections and interpretations as may be necessary for fulfilling the intent of the Contract Documents.

1.02 DEFINITIONS

- A. These specifications use “Article 1 - Definitions” of the Standard General Conditions of the Construction Contract, C-700, prepared and issued by Engineers Joint Contract Documents Committee (EJCDC, 2018), as the basis for the definition of terms herein. Changes in these definitions shall be made either by substitution for that article or as Supplementary Conditions.
- B. Additional definitions and clarification of terms:
 - 1. Provide: Furnish and install, complete with all necessary ancillary items, ready for intended use. Pay for all related costs.
 - 2. Approved: Acceptance of an item submitted for approval. Not a limitation or release for compliance with the Contract Documents or any regulatory requirements.
 - 3. Match Existing: Construct new work to conform to the existing lines and grades of the site and facilities as acceptable to Owner.
 - 4. Supplementary Specifications: Permanent additions to and revisions of these specifications, covering conditions, which are not unique to any one project. Supplementary Specifications will govern over these specifications, including the Standard Drawings, when in conflict therewith.

5. Special Provisions: Additions and revisions to these specifications covering special conditions on an individual project. Special Provisions will govern over project Drawings and supplementary documents, Supplementary Specifications, Standard Drawings, and these specifications when in conflict therewith.

END OF SECTION

SECTION 01340 — SUBMITTALS

PART 1 GENERAL

1.01 SUMMARY

- A. Comply with Submittal format requirements as specified in the Contract Documents.
- B. Provide the numbers and types of submittals listed in individual sections of the Contract Documents. If not specified elsewhere, provide the following as a minimum:
 - 1. Shop drawings: One reproducible and two blueline or photocopy prints. Reviewed and annotated by Contractor.
 - 2. Product data: Four copies.
 - 3. Samples: Two each plus extra samples as required to indicate range of color, finish, and texture.
 - 4. Mock-ups: Number as required in the individual sections.
 - 5. Warranties: Four copies.
 - 6. Closeout submittals: Four copies.
- C. Provide required resubmittals in the appropriate distribution if original submittals are not approved.
- D. Samples and shop drawings shall be prepared specifically for this project. Shop drawings shall include dimensions and details, including adjacent construction and related work. Note any special coordination required. Note any deviations from requirements of the Contract Documents.
- E. Provide warranties as specified. Warranties shall not limit length of time for remedy of damages Owner may have by legal statute. Warranties shall be signed by Contractor, Supplier, or Installer responsible for performance of warranty.

END OF SECTION

SECTION 01442 — PARTNERING

PART 1 GENERAL

1.01 SUMMARY

- A. This section presents an alternate project delivery system whereby Owner, Contractor and Engineer formally agree to work as a team to achieve the project goals.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 FACILITATOR

- A. A professional Facilitator is employed to oversee and guide a meeting of decision-making personnel from every entity involved in the project. The Facilitator explains the process and paves the way to collective understanding.

3.02 PROCESS

- A. Executive (decision-making) people from involved entities, generally Owner, Contractor, Engineer/Architect meet to, by mutual agreement, explore each other's concepts of their roles in the project as well as their own. The Facilitator guides the discussion and aids in establishing project goals such as avenues to avoiding disputes, quick resolution of problems. Establishment of communication with agreed upon paths to success for everyone involved is the goal. The strength of the process is the mutual commitment. Actually, everyone signs onto the pact.

PART 4 METHOD OF MEASUREMENT AND BASIS OF PAYMENT

4.01 METHOD OF MEASUREMENT

- A. Various methods are used at this point to pay for the Facilitator and the meeting facility. Payment can be a bid item, or it can be paid by Owner directly. Usually officers of each entity volunteer their time for the initial meeting.

END OF SECTION

SECTION 01505 — TEMPORARY FACILITIES

PART 1 GENERAL

1.01 SUMMARY

- A. Furnish temporary services and utilities, including use fees and operation costs:
 - 1. Potable and non-potable water
 - 2. Lighting and power
 - 3. Materials storage
- B. Furnish construction facilities, including utility costs:
 - 1. Construction equipment
 - 2. Dewatering and pumping
- C. Furnish security and protection requirements:
 - 1. Fire extinguishers
 - 2. Site enclosure fence, barricades, warning signs, and lights
 - 3. Snow and ice removal, if applicable
- D. Furnish personnel support facilities:
 - 1. Sanitary facilities
 - 2. Drinking water
 - 3. First aid facilities
 - 4. Coordinate emergency medical services
 - 5. Trash removal

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

PART 4 METHOD OF MEASUREMENT AND BASIS OF PAYMENT

4.01 METHOD OF MEASUREMENT

- A. No separate measurement will be made for items under this section. Full compensation shall be considered as included in the prices paid for the various contract items and no additional compensation will be allowed.

4.02**BASIS OF PAYMENT**

- A. No separate payment will be made for items under this section. Full compensation shall be considered as included in the prices paid for the various contract items and no additional compensation will be allowed.

END OF SECTION

SECTION 01601 – MOBILIZATION

PART 1 GENERAL

1.01 SUMMARY

- A. Preparatory operations.
- B. Movement of personnel, equipment, supplies and incidentals to the project site.
- C. Establishment of temporary offices, buildings and other facilities.
- D. Other Work and operations which must be performed prior to beginning Work on the various items on the project.
- E. Materials in storage is not included in calculation of Bid Items worked.
- F. Demobilization.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

PART 4 METHOD OF MEASUREMENT AND BASIS OF PAYMENT

4.01 METHOD OF MEASUREMENT

- A. Computed monthly based on the percentage of the original contract amount earned by Bid Items worked, (Total work completed), and Change Orders approved, in accordance with the following:
 - 1. When the percentage of the original contract amount shown in Column 1 is earned, the percentage of the contract lump sum price for mobilization shown in Column 2 or the percentage of the original contract amount shown in Column 3, whichever is lesser, will be paid.

Column 1	Column 2	Column 3
Percentage of Original Contract	Percentage of Lump Sum Price For	Percentage of Original Contract Amount
Amount Earned	Mobilization	
0	0	0
1	10	1
5	25	2.5
10	50	5
25	60	6
50	70	7
70	100	10

- 1. Upon substantial completion of Work on the project, payment of any amount bid for mobilization in excess of 10% of the original contract amount will be paid.

1. Intermediate values will be computed on the basis of straight-line interpolation.
2. Pay remainder of mobilization bid item including any amount in excess of 10% of the original contract amount.

4.02

BASIS OF PAYMENT

- A. Lump Sum – Payment shall be made at the lump sum quote for this item in the “Bid Schedule” and shall be for the preparatory work and operations including, but not limited to, those necessary for the movement of personnel, equipment, supplies and incidentals to the project site; for the establishment of all offices, buildings, and other facilities necessary for the work on the project; and for all other work and operations which must be performed, or costs incurred prior to beginning work on the various items on the project, and removal of those items at the completion of the work.

Bid Item	Pay Unit
Mobilization	LS

END OF SECTION

SECTION 02050 — REMOVAL AND DISPOSAL OF STRUCTURES AND OBSTRUCTIONS

PART 1 GENERAL

1.01 SUMMARY

- A. The work involved in this category shall consist of removing and satisfactorily disposing of existing asphalt pavement, portland cement pavement, concrete curb, combined curb and gutter, sidewalk, private driveways, crosswalks, fences, abandoned pipelines, buildings and any other structure or obstruction designated for removal on the plans.
- B. Removed items shall be properly disposed of as required by Federal, State, and Local Government regulations. Engineer shall receive written notification of disposal procedures and may require Contractor to certify that proper disposal methods were used.
- C. It shall also include the salvaging of designated material, as shown on the plans, and backfilling the resulting trenches, holes, and pits.
- D. Materials removed and not designated to be salvaged or incorporated into the work shall become the property of Contractor.

1.02 RELATED WORK

- A. Demolition of asphalt and portland cement concrete. Section 02075
- B. Clearing and grubbing. Section 02110
- C. Selective clearing. Section 02115

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 CONSTRUCTION METHODS

- A. Demolition and disposal.
 - 1. All existing pavement, curb, gutter, sidewalks, driveways, crosswalks, fences, abandoned pipelines, buildings or any other structure or obstruction specified for removal on the plans or as directed by Engineer, shall be removed and disposed of by Contractor.
 - 2. Care shall be exercised in such removal to assure that adjacent facilities or structures which are to remain shall not be disturbed.
 - 3. Any damage to such existing facilities or structures resulting from carelessness or negligence on Contractor's part shall be satisfactorily restored to its original condition at Contractor's expense.

4. Existing pavement shall be cut and removed to the lines indicated on the plans, or as directed by Engineer.
5. Existing private concrete driveways or sidewalks which interfere with construction of street improvements, or which do not match for grade shall be removed as shown on the plans or as directed by Engineer. Removal shall be on a neat line produced by a concrete saw cut.

3.02 REMOVAL OF PIPE

- A. Pipe designated for salvage shall be removed and cleaned. Every precaution shall be taken to avoid breaking or damaging the pipe. Pipes to be re-laid shall be removed and stored so that there will be no loss or damage before relaying. Contractor shall replace at his expense, sections lost from storage or damaged by negligence or by use of improper methods.

PART 4 METHOD OF MEASUREMENT AND BASIS OF PAYMENT

4.01 METHOD OF MEASUREMENT

- A. When the contract stipulates, payment will be made for removal of obstructions on a lump sum basis. No measurement of individual items will be required.
- B. When the contract stipulates, payment will be made for each item removed at unit prices. Each item removed will be measured at the bid schedule unit of measurement.

4.02 BASIS OF PAYMENT

- A. Lump Sum – Payment shall be made at the lump sum quote for this item in the “Bid Schedule” and shall be for the removal of all obstructions including pipe, and structures encountered within the right-of-way. Payment will include required excavation and backfill.
- B. Unit Price – Payment for specific obstruction items including pipe shall be paid for at the measured quantities removed multiplied by the unit price per each as called out in the “Bid Schedule”.
- C. When the “Bid Schedule” does not contain pay items for removal of structures and obstructions including pipe removal, the work will not be paid for directly, but will be considered as a subsidiary obligation of Contractor under other contract items.

END OF SECTION

SECTION 02075 — DEMOLITION OF ASPHALT AND PORTLAND CEMENT CONCRETE

PART 1 GENERAL

1.01 SUMMARY

- A. This section consists of removal of all surfacing material encountered.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Clearing and grubbing. Section 02110
B. Selective clearing. Section 02115

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 PAVEMENT REMOVAL

- A. Where trench excavation or structure excavation requires the removal of curb and gutter, concrete sidewalks, or asphaltic or concrete pavement, the pavement or concrete shall be cut in a straight line parallel to the edge of the excavation by use of a spade-bitted air hammer, concrete saw or similar approved equipment to obtain a straight, square clean break. Pavement cuts shall be 2 feet wider than the actual trench opening and centered over such trench.

PART 4 METHOD OF MEASUREMENT AND BASIS OF PAYMENT

4.01 METHOD OF MEASUREMENT

- A. Unless otherwise noted in the special provisions, no separate measurement will be made for items under this section. Full compensation shall be considered as included in the prices paid for the various contract items and no additional compensation will be allowed.

4.02 BASIS OF PAYMENT

- A. Unless otherwise noted in the special provisions, no separate payment will be made for items under this section. Full compensation shall be considered as included in the prices paid for the various contract items and no additional compensation will be allowed.

END OF SECTION

SECTION 02110 — CLEARING AND GRUBBING

PART 1 GENERAL

1.01 SUMMARY

- A. This work shall consist of clearing, grubbing, removing, and disposing of all vegetation and debris within the limits of the construction area. Vegetation and objects designated to remain shall be preserved from injury or defacement.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 CONSTRUCTION

- A. Unless otherwise established by Engineer, all areas between lines 2 feet outside the back of sidewalk, curb and/or curb and gutter, or within the neat lines of cut or fill areas shall constitute the clearing and grubbing limits. Where sidewalk, curb and/or curb and gutter is not required, the clearing limits shall be 2 feet outside the edge of pavement or within the neat lines of cut or fill areas.
- B. All stumps, roots, logs or other timber more than 3 inches in diameter, and all brush, matted roots and other debris within the grubbing limits not suitable for street foundation shall be pulled or otherwise removed to a depth of not less than 6 inches below the original ground or 12 inches below street subgrade.
- C. The refuse resulting from the clearing and grubbing operation may be hauled to an available waste site approved by Owner and shall be disposed of in such a manner as to meet all requirements of State, county and municipal regulations regarding health, safety, and public welfare. When authorized by the proper fire authorities, Contractor may dispose of such refuse by burning on the site of the project provided all requirements set forth by the authorities are met.
- D. On easements through private property, Contractor shall not burn on the site unless specifically permitted by the Property Owner in which case he shall obtain permission as previously stated.
- E. In all cases, the authority to burn shall not relieve Contractor in any way from damages which may result from his operations. In no case shall any material be left on the project, shoved onto abutting private properties, or be buried in embankments or trenches on the project.
- F. Contractor shall avoid, as far as practicable, injury to shrubbery, vines, plants, grasses and other vegetation growing on areas outside of the grading area, or on parking strips or adjacent lots.

PART 4 METHODS OF MEASUREMENT AND BASIS OF PAYMENT

4.01 METHOD OF MEASUREMENT

A. Measurement will be by one or more of the following alternate methods:

1. Area Basis. The work to be paid for will be the number of acres and fractions thereof acceptably cleared or grubbed, or both, within the limits shown on the plans or staked for clearing and grubbing by Engineer. Areas not shown on the plans, or not staked for clearing and grubbing, will not be measured for payment.
2. Lump Sum Basis. When the bid schedule contains a clearing and grubbing lump sum item, no measurement of area will be made.
3. Individual Unit Basis.
 - a. The diameter of trees will be measured at a height of 24 inches above the ground. Trees less than 4 inches in diameter will be classed as brush.
 - b. When the bid schedule indicates measurement by individual unit basis, the units will be designated and measured in accordance with the following schedule of size:

DIAMETER OF A TREE AT HEIGHT OF 24 INCHES	PAY ITEMS DESIGNATION
INCHES	
4 to 8	6-inch size each
Over 8 to 12	10-inch size each
Over 12 to 24	18-inch size each
Over 24 to 36	30-inch size each
Over 36 to 60	48-inch size each
Over 60	60-inch size each

- c. Stumps will be measured by taking the average diameter at the cutoff.

4.02 BASIS OF PAYMENT

- A. The accepted quantities of clearing and grubbing will be paid for at the contract unit prices as follows:
1. Area Basis. The quantities determined will be paid for at the contract unit bid price per acre for each of the particular pay items listed on an area basis under this Subsection.
 2. Lump Sum Basis. When the bid schedule contains a lump sum item, the lump sum price shall be full compensation for all clearing, grubbing, or clearing and grubbing required.
 3. Individual Unit Basis. When individual unit quantities are shown on the bid schedule, the accepted quantities will be paid for at the contract unit price for the respective items.

4. Exclusions. When the bid schedule does not contain an estimated quantity or lump sum item for clearing and grubbing, the work will not be paid for directly, but will be considered as a subsidiary obligation of Contractor under other contract items.

Payment will be made under:

PAY ITEM	PAY UNIT
Clearing	Acre, LS
Grubbing	Acre, LS
Clearing and Grubbing	Acre, LS
Clearing Trees Diameter Range from Table, page 2 of 3	Each

END OF SECTION

SECTION 02115 — SELECTIVE CLEARING

PART 1 GENERAL

1.01 SUMMARY

- A. This section consists of all necessary clearing, grubbing and site preparation; removal of all material of whatever description that may be encountered; and removal and disposal of debris.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 STRIPPING

- A. When crossing existing or prospective cultivated areas, gravel streets or other developed surfaces, Contractor shall strip the cover material to full depth at the existing surfacing. This surfacing shall be stockpiled and placed back over the trench after backfilling to the extent that it is acceptable and usable for that purpose. Topsoil shall be removed to full depth of the topsoil, or to a maximum depth of 12 inches, whichever is less.
- B. All established lawn areas cut by the trench or damaged during the course of the work shall be restored to a condition comparable to its surrounding area and to the complete satisfaction of Engineer.

PART 4 METHOD OF MEASUREMENT AND BASIS OF PAYMENT

4.01 METHOD OF MEASUREMENT

- A. Unless otherwise noted in the special provisions, no separate measurement will be made for items under this section.

4.02 BASIS OF PAYMENT

- A. Unless otherwise noted in the special provisions, no separate payment will be made for items under this section. Full compensation shall be considered as included in the prices paid for the various contract items and no additional compensation will be allowed.

END OF SECTION

SECTION 02150 — SHORING AND UNDERPINNING

PART 1 GENERAL

1.01 SUMMARY

- A. This section consists of all necessary bracing, shoring and protection, required for open excavations.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 CONSTRUCTION

- A. All excavation, trenching and shoring, and the like, under this contract shall be performed in a manner that meets with the latest edition of the OSHA Department of Labor, Safety and Health Regulations for Construction.

PART 4 METHOD OF MEASUREMENT AND BASIS OF PAYMENT

4.01 METHOD OF MEASUREMENT

- A. Unless otherwise noted in the special provisions, no separate measurement or payment will be made for items under this section, full compensation shall be considered as included in the prices paid for the various contract items and no additional compensation will be allowed.

4.02 BASIS OF PAYMENT

- A. Unless otherwise noted in the special provisions, no separate payment will be made for items under this section. Full compensation shall be considered as included in the prices paid for the various contract items and no additional compensation will be allowed.

END OF SECTION

SECTION 02190 — AGGREGATES

PART 1 GENERAL

1.01 SUMMARY

- A. This section includes the preparation and stockpiling of aggregates for portland cement concrete, bases, bituminous pavements, and surface treatments, cover coats, bed courses, drains, pervious backfill and riprap.
- B. This section is a material specification only and is subsidiary to other sections which address placement of the materials prepared under same.

1.02 RELATED WORK

- A. Section 02231, Aggregate Sub-base and Base Courses
- B. Section 02273, Riprap
- C. Section 03304, Portland Cement Concrete
- D. Section 02511, Road Mix Bituminous Pavements
- E. Section 02512, Plant Mix Pavements
- F. Section 02550, Prime Coat
- G. Section 02552, Seal Coat
- H. Section 02553, Bituminous Surface Treatment

1.03 REFERENCES

- A. AASHTO M6: Fine Aggregate for Hydraulic Cement Concrete
- B. AASHTO M80: Coarse Aggregate for Hydraulic Cement Concrete
- C. AASHTO M92: Wire-Cloth Sieve for Testing Purposes
- D. AASHTO R90: Standard Practice for Sampling Aggregate Products
- E. AASHTO T27: Sieve Analysis of Fine and Coarse Aggregates, Wyoming Modified
- F. AASHTO T96: Standard Method of Test for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
- G. AASHTO T104: Standard Method of Test for Soundness of Aggregate by Use of Sodium Sulfate or Magnesium Sulfate
- H. ASTM C33: Concrete Aggregates
- I. ASTM C127: Density, Relative Density (Specific Gravity), and Absorption of Coarse Aggregate

J. ASTM C136: Sieve Analysis of Fine and Coarse Aggregate

1.04

SUBMITTAL

- A. Sampling and testing of aggregates for flexible pavements shall be in accordance with the following standard methods of the American Association of State Highway Transportation Officials (AASHTO):
- | | |
|-----------------------|-----------------------|
| 1. Sampling | R90 |
| 2. Percentage of Wear | T96 |
| 3. Soundness | T104 |
| 4. Sieve Analysis | T27, Wyoming Modified |
| 5. Sieve Analysis | ASTM C136 |
- B. Sampling and testing of aggregates for portland cement concrete shall be in accordance with the following standard methods of the American Association of State Highway Transportation Officials (AASHTO):
- | | |
|-----------------------|-----------------------|
| 1. Fine Aggregate | M6 |
| 2. Coarse Aggregate | M80 |
| 3. Sieve Analysis | T27, Wyoming Modified |
| 4. Percentage of Wear | T96 |
| 5. Soundness | T104 |

1.05

DEFINITIONS

- A. Coarse aggregate shall mean materials retained on a #4 sieve.
- B. Fine aggregate shall mean materials passing a #4 sieve.
- C. Sub-base shall be crushed sub-base unless otherwise specified.
- D. Base shall be crushed base unless otherwise specified.
- E. Gradation requirements, as listed herein, shall be the percentage of material by weight passing laboratory sieves having square openings. Sieve sizes or designations will be in accordance with AASHTO M92 and ASTM C33.

PART 2

PRODUCTS

2.01

MATERIALS

- A. When crushed aggregate for sub-base, bases, surfacing, or bituminous pavements is specified, all boulders in the pit up to 6 inches in diameter shall be crushed to meet the required specifications and shall be uniformly distributed in the remainder of the material, unless otherwise specified.

- B. Before production of any of the following materials, all vegetation and stripping material shall be removed from the pit. Only designated portions of the pit will be used. The composite materials shall be free from clay balls, vegetable matter, and other deleterious substances, and shall not contain an excess of thin or elongated pieces.

2.02

AGGREGATE FOR PORTLAND CEMENT CONCRETE

A. FINE AGGREGATE

1. Fine aggregate for concrete shall conform to the requirements of AASHTO M6 with the following exceptions:

2. Max. % by Weight

Clay Lumps 0.5

Coal, Lignite, or Shale 0.3

Material Passing No.200 Sieve 4.0

The sum of the above materials and other deleterious substances such as shale, alkali, mica, coated grains, or soft and flaky particles shall not exceed 4 percent by weight.

3. Fine aggregate shall be well graded from coarse to fine and shall conform to the following gradation requirements:

SIEVE DESIGNATION	PERCENTAGE PASSING
3/8"	100
#4	95-100
#16	45-80
#50	10-30
#100	2-10

B. COARSE AGGREGATE

1. Coarse aggregates shall consist of crushed stone, gravel, or other approved inert materials of similar characteristics, or combinations thereof, having strong and durable pieces. The aggregate shall be free from vegetable matter, lumps or balls of clay, adherent films of clay, or other matter that would prevent thorough bonding in accordance with Paragraph 2.

2. Coarse aggregate shall conform to the requirements of AASHTO M80 with the following exceptions:

- a. The amount of deleterious substances shall not exceed the following limits:

Max. % by Weight

Clay Lumps 0.5

Coal, Lignite, or Shale 0.1

Material Passing #200 Sieve 2.0

Other deleterious substances such as friable, thin, elongated, or laminated pieces 3.0

The sum of the above material and other deleterious substances shall not exceed 5 percent by weight.

- b. Coarse aggregates shall have a percentage of wear of not more than 40 when tested in accordance with AASHTO T96 or show a sodium sulfate loss not to exceed 12 percent when tested in accordance with AASHTO T104. The wear and soundness requirements may be waived, or modified, by Engineer provided that the coarse aggregate has a proven service record for similar conditions.
- c. Coarse aggregate shall meet the following gradation limits for the concrete class specified. Other sizes or combinations of sizes may be used when otherwise specified. If not specified, Type No. 57 shall be the gradation used.

SIEVE DESIGNATION	TYPE NO. 57	TYPE NO. 67
1½"	100	-
1"	95-100	100
¾"	-	-
½"	25-60	-
⅜"	-	20-55
*#4	0-10	0-10

* Not more than 5% shall pass the #8.

2.03

AGGREGATE FOR UNTREATED SUB-BASE AND BASE

- A. The composite materials shall be free from clay balls, vegetable matter, and other deleterious substances, and shall not contain an excess of thin or elongated pieces.
- B. Crushed sub-base and crushed base shall be crushed stone or crushed gravel and an approved soil binder or natural filler, where required, conforming to the following requirements, unless otherwise designated in the Contract Documents.
 - 1. Coarse aggregate shall consist of hard, durable particles or fragments of stone or gravel. Materials that break up when alternately frozen and thawed or wetted and dried shall not be used. Unless otherwise specified, the coarse aggregate shall have a percentage of wear of not more than 50.
 - 2. Fine aggregate shall consist of crushed stone, crushed gravel, or natural sand. The fraction passing the #200 sieve shall not be greater than two-thirds of the fraction passing the #40 sieve. The fraction passing the #40 sieve shall have a liquid limit not greater than 25 and a plasticity index not greater than 6 except that, when the plasticity index is non-plastic (NP), the liquid limit shall not be more than 30.
 - 3. Crushed base and crushed sub-base shall meet one of the following gradation requirements as specified in the Contract Documents:

SIEVE DESIGNATION	GRADING D	GRADING G	GRADING H	GRADING J	GRADING K	GRADING W
2"	100	100	-	100	-	-
1½"	90-100	90-100	-	90-100	100	100
1"	-	-	100	-	90-100	90-100
¾"	-	-	90-100	-	-	-
#4	50-85	-	45-65	35-75	40-65	45-65
#8	40-70	-	33-53	-	30-55	33-53
#200	2-5	0-15	3-12	0-15	3-15	3-12

- C. Crusher run sub-base and crusher run base shall be crusher run material of the maximum size as called for in the Contract Documents, not to exceed 3 inches.
- D. Pit run or screened sub-base and base shall be pit run or screened material of the maximum size called for in the Contract Documents, not to exceed 3 inches.
- E. Placement of sub-base materials with aggregates greater than 3 inches shall not be allowed unless otherwise specified by Engineer in the Special Provisions.

2.04

AGGREGATE FOR PLANT MIX BITUMINOUS BASE

- A. GENERAL - Aggregate shall be composed of coarse and fine aggregates combined in the proper proportions to meet the grading requirements for Grading W of Subsection 2.03 herein, AGGREGATE FOR UNTREATED SUB-BASE AND BASE, unless otherwise noted in the Contract Documents. Aggregates shall be composed of clean, tough, durable fragments free from an excess of flat, elongated, soft, or disintegrated pieces and free from fragments coated with dirt or other objectionable matter.
- B. COARSE AGGREGATE - Coarse aggregate shall be crushed stone, crushed gravel, or natural gravel. Unless otherwise shown noted in the Contract Documents, the material shall have a percentage of wear of not more than 50 when tested in accordance with AASHTO T96. The sodium sulfate soundness loss shall not exceed 12% in accordance with AASHTO T104.
- C. FINE AGGREGATE - Fine aggregate shall consist of crushed stone, crushed gravel, or natural sand. The fraction passing the #200 sieve shall not be greater than two-thirds of the fraction passing the #40 sieve. The fraction passing the #40 sieve shall have a liquid limit not greater than 25 and a plasticity index not greater than 3, except that when the plasticity index is non-plastic (NP), the liquid limit shall be not more than 30.

2.05

AGGREGATE FOR ROAD MIX BITUMINOUS BASE

- A. Aggregates for road mix bituminous base shall meet the requirements for Crushed Base of Subsection 2.03 herein, AGGREGATE FOR UNTREATED SUB-BASE AND BASE and unless otherwise specified by Engineer in the Special Provisions, the combined aggregate and natural filler, where required, shall meet the gradation requirements for Grading W.

2.06**AGGREGATE FOR FLEXIBLE PAYMENTS**

- A. GENERAL - Aggregates shall be of uniform quality, crushed to size as necessary, and shall be composed of sound, tough, durable pebbles or fragments with or without natural or mineral fillers, as required. The aggregate shall be free from vegetable matter, lumps or balls of clay, adherent films of clay or other matter that would prevent thorough coating with bituminous material and shall be free of an excess of flat or elongated pieces. The crushed aggregate shall have a percentage of wear of not more than 40, show a sodium sulfate loss of not more than 12 percent, and a plasticity index shall not exceed 3 unless otherwise provided for in the Contract Documents or as approved by Engineer.
- B. COARSE AGGREGATE - Coarse aggregate shall be crushed stone or crushed gravel of such gradation that when combined with other required aggregate fractions and fillers in proper proportion, the resultant mixture shall meet the gradation requirements under the composition of mixture for the specific material type. Only one kind shall be used on the Project except as approved by Engineer.
- C. FINE AGGREGATE - Fine aggregate shall consist of crushed stone, crushed gravel, or natural sand. Fine aggregate shall be of such gradation that when combined with other required aggregate fractions in proper proportion, the resultant mixture shall meet the gradation requirements under the composition of mixture for the specific material type. Only one kind shall be used on the Project except as approved by Engineer.

2.07**AGGREGATE FOR HOT PLANT MIX BITUMINOUS PAVEMENT**

- A. Type I Pavement aggregate shall be composed of coarse and fine aggregates combined as shown and in conformance with Subsection 2.04 herein, AGGREGATE FOR PLANT MIX BITUMINOUS BASE.
- B. Type II Pavement aggregate material, prior to crushing, shall be of such size that not less than 95 percent shall be retained on a sieve with square openings $\frac{1}{4}$ inch larger than the maximum size mineral aggregate being produced, unless otherwise specified by Engineer in the Special Provisions.
- C. Type III Pavement aggregate shall have not less than 50 percent of the materials by weight retained on the #4 sieve with at least one fractured face, unless a different percentage of fractured faces is otherwise specified in the Contract Documents.
- D. The several aggregate fractions for the mixture shall be sized, graded, and combined in such proportions that the resulting composite blend meets one of the grading requirements in the following table as specified in the Contract Documents. For nominal lift thicknesses of less than 1-1/2 inches, Contractor shall use the 3/8-inch nominal maximum aggregate size grading specification. If not otherwise specified, Contractor shall use the 1/2-inch nominal maximum aggregate size grading specification.

SIEVE DESIGNATION	% BY WEIGHT PASSING		
Inches	¾ inch	½ inch	3/8 inch
1"			-
3/4"	90 to 100	100	-
1/2"	55 to 90	90 to 100	100
3/8"	45 to 85	55 to 90	90 to 100
#4	30 to 65	35 to 70	45 to 85
#8	20 to 50	20 to 55	30 to 65
#30	5 to 30	5 to 35	10 to 40
#200	2 to 7	2 to 7	2 to 7

2.08 AGGREGATE FOR PLANT MIX WEARING COURSE

- A. The aggregate for plant mix wearing course shall be crushed stone or gravel composed of hard, durable pebbles or fragments and a filler of finely crushed stone, gravel, or sand, where required, to provide a composition of aggregates meeting the following requirements for the type specified:

SIEVE DESIGNATION	% BY WEIGHT PASSING	
Inches	Type A	Type B
1/2"	100	100
3/8"	97-100	97-100
#4	25-45	20-40
8	10-25	10-20
#200	2-7	2-7

- B. The aggregate shall be free from vegetable matter, lumps, or balls of clay adherent films of clay, or other matter that would prevent thorough coating with bituminous material. Unless otherwise shown on the plans, at least 75 percent of the material by weight retained on the #4 sieve shall be particles having at least one fractured face and shall have a percentage of wear of not more than 35.
- C. When either Type A or Type B wearing course is specified, the aggregate material, prior to crushing, shall be of such size that not less than 95 percent shall be retained on a sieve with square openings of 3/8 inch.

2.09 AGGREGATE FOR ROAD MIX BITUMINOUS PAVEMENT

- A. Aggregates shall be composed of clean, tough, durable fragments of crushed stone, or crushed or natural gravel free from an excess of flat, elongated, soft, or disintegrated pieces. The aggregate shall be free from vegetable matter, lumps or balls of clay, adherent films or other matter that would prevent thorough coating with bituminous material.
- B. Unless otherwise specified, the coarse aggregate shall have a percentage of wear of not more than 50. The sodium sulfate soundness loss shall not exceed 12 percent and the plasticity index shall not exceed 3. The combined coarse and fine aggregate shall meet the following gradation requirements:

SIEVE DESIGNATION	% BY WEIGHT PASSING
1"	100
3/4"	95-100
#4	45-65
#8	33-53
#200	3-12

2.10

AGGREGATE FOR COVER COAT

- A. Only one type of aggregate shall be used on the project unless alternate types are approved.
- B. Cover aggregate for seal coats shall be crushed stone, crushed ledge rock, crushed or natural gravel, or sand.
- C. Cover aggregate material for bituminous surface treatment shall consist of clean, tough, durable fragments free from an excess of flat, elongated, soft or disintegrated pieces and free from coatings of dirt or other objectionable matter. The aggregate shall have neither a percentage of wear of more than 40 nor a plasticity index in excess of 3. The aggregate material shall be well graded from coarse to fine within the following limits:

SIEVE DESIGNATION	% BY WEIGHT PASSING
3/8"	100
#4	70-90
#8	45-70
#16	28-50
#30	19-34
#50	12-25
#100	7-18
#200	5-15

- D. Type B, C, D, E, K, and S aggregate material produced shall be well graded from coarse to fine within the following limits:

SIEVE DESIGNATION	% BY WEIGHT PASSING					
	Type B	Type C	Type D	Type E	Type K	Type S
Inches						
1"	-	-	-	-	-	-
3/4"	100	-	100	100	-	-
1/2"	95-100	100	95-100	95-100	100	100
3/8"	40-70	80-100	-	-	95-100	95-100
#4	0-15	0-10	0-15	35-70	0-35	85-100
#8	0-7	0-5	0-7	-	0-20	-
#200	0-2	0-2	0-2	0-10	0-3	0-5

1. Types B, C, and K. Nonplastic crushed stone or gravel, of which, before crushing, at least 95 percent is retained on a ½-inch [12.5 mm] sieve.
2. Types B and C. Process produced aggregate over a slotted screen that has openings ¼ in. [6.25 mm] wide by at least ¾ in. [18.75 mm]. Do not use material that passes through the screen.

3. Type D. Crushed stone or gravel, or clean pea gravel.
4. Types B, C, D, and K. LA abrasion loss maximum of 35 percent.
5. Type E. Crushed sand-gravel.
6. Type S. Screened or pit-run sand.
7. Type E and S. Plasticity index no greater than 3.

2.11 AGGREGATE FOR BLOTTER

- A. Blotter material shall be either sand or screenings, free from vegetable matter, or other deleterious matter. The material shall be of such size that 100 percent of the material will pass through a 3/8-inch sieve, the fraction passing the #4 sieve shall be from 85 percent to 100 percent and the fraction passing the #200 sieve shall not be greater than 20 percent. The plastic index shall not exceed 6.

2.12 AGGREGATE FOR FILLER

- A. Filler shall consist of clean, hard, durable grains of naturally occurring granular material taken either from locations shown on the Drawings or from approved sources as otherwise specified in the Contract Documents.

2.13 AGGREGATE FOR BED COURSE MATERIAL

- A. Bed course material for sidewalks and curbing shall consist of graded gravel, crushed stone, or other approved material of such that all particles will pass through a sieve having 1/2-inch-square openings.

2.14 AGGREGATE FOR DRAINS

- A. Gravel for drains shall be crushed or natural sand and gravel or other approved free-draining material. The material shall be uniformly graded from coarse to fine within the following gradation requirements for the material type indicated in the Contract Documents. When the grading is not indicated in the Contract Documents, Grading B shall be used.

SIEVE DESIGNATION	% BY WEIGHT PASSING		
	Grading A	Grading B	Grading C
Inches			
2"	100	-	-
1 1/2"	95-100	100	-
1"	-	95-100	-
3/4"	35-70	-	100
3/8"	10-30	-	95-100
#4	0-5	0-10	-
#8	-	-	65-95
#16	-	-	5-30
#100	-	-	0-10

2.15**AGGREGATE FOR MAINTENANCE STOCKPILES**

- A. Type A aggregate shall consist of clean, hard, durable particles of crushed gravel or stone free from soft, thin, elongated, or laminated pieces or organic material, and shall show a percentage of wear of not more than 50. The fraction passing the #40 sieve shall have a liquid limit not greater than 25 and a plasticity index not greater than 3, except that, when the plasticity index is non-plastic (NP), the liquid limit shall not be more than 30. The material placed in the stockpile shall meet the following gradation requirements for the maximum size specified:

SIEVE DESIGNATION	% BY WEIGHT PASSING	
Inches	½" Max.	3/8" Max.
¾"	100	-
½"	90-100	100
3/8"	60-90	90-100
#4	45-65	50-80
#8	30-50	33-63
#200	3-12	3-12

- B. Type B aggregate shall consist of clean, hard, durable particles of crusher-run gravel or stone free from soft, thin, elongated, or laminated pieces or organic material. Material shall be obtained from designated portions of the pit. The plasticity index shall not be greater than 6. The material placed in the stockpile shall meet the following gradation requirements for the maximum size specified:

SIEVE DESIGNATION	% BY WEIGHT PASSING
Maximum Designated	95-100
#4	0-75
#200	0-15

- C. Type C aggregate shall consist of crusher-run scoria. Not less than 95 percent of the material placed in the stockpile shall pass a 1/2-inch sieve.
- D. Type D aggregate shall consist of clean, hard, durable particles of screened sand free from soft, thin, elongated or laminated pieces, or organic material. The plasticity index shall not be greater than 6. The material placed in the stockpile shall meet the following gradation requirements:

SIEVE DESIGNATION	% BY WEIGHT PASSING
1/2"	100
3/8"	95-100
#4	85-100
#200	0-15

2.16**AGGREGATE FOR PERVIOUS BACKFILL MATERIAL**

- A. Pervious Backfill Material shall consist of gravel, crushed gravel, crushed rock, natural sands, manufactured sands, or combinations thereof, and shall meet the following gradation requirements:

SIEVE DESIGNATION	% BY WEIGHT PASSING
2"	100
#4	0-50
#40	0-35
#100	0-10
#200	0-4

- B. In addition, the fraction passing the #40 sieve shall be non-plastic (NP) and shall have a liquid limit not greater than 30.

2.17

AGGREGATE FOR RIPRAP

- A. Aggregate for riprap shall be hard, durable, crushed, quarried, or natural stone, or broken concrete having an apparent specific gravity of 2.4 or greater. The absorption shall not exceed 4 percent unless otherwise approved by Engineer in the Special Provisions. The stone shall be free of weak laminations and cleavages and shall be of a quality that will not disintegrate on exposure to water or weathering. The aggregate for the various types of riprap shall meet the following additional requirements:
1. Class I Riprap aggregate shall consist of two sizes of stone.
 - a. Primary stones shall be not less than 3-inch thick and shall weigh not less than 50 pounds. At least 60 percent of the stones shall weigh more than 80 pounds each.
 - b. Choke stones shall be fragments or spalls of the proper size to satisfactorily wedge between the primary stones as placed.
 2. Class 2 Riprap aggregate shall be graded with a sufficient amount of smaller stones uniformly distributed throughout. At least 60 percent of the stones shall weigh more than 80 pounds each.
 3. Grouted Riprap aggregate shall conform to the specifications for Class I or Class 2 Riprap. If not specified, Class I Riprap shall be used.
 4. Wire Enclosed Riprap aggregate shall be round or angular stones. Not less than 95 percent of the stone shall be retained on a screen or wire having 2-inch-square openings.
 5. Sacked Concrete Riprap aggregate shall consist of either a sandy or gravelly pit-run material. This material shall be clean and free from roots, vegetable matter, or other deleterious substances. The aggregate shall meet the following gradation requirements:

SIEVE DESIGNATION	% BY WEIGHT PASSING
2"	80 - 100
#200	0 - 4

2.18**AGGREGATE FOR RIPRAP FILTER**

- A. Filter aggregates for riprap shall be hard, durable particles or fragments of crushed stone or natural gravel, screened or crushed to meet the following gradation requirements:

SIEVE DESIGNATION	% BY WEIGHT PASSING
3"	100
# 4	20 - 50
#200	0 - 10

PART 3**EXECUTION****3.01****STOCKPILED AGGREGATE**

- A. This work shall consist of storing aggregate material which will be used in construction projects in accordance with these specifications at locations shown on the Drawings, noted in the Contract Documents, or as otherwise designated by Engineer.
- B. The aggregates shall meet applicable parts of this section for the type of material required.
- C. Sites for aggregate stockpiles shall be grubbed and cleaned prior to storing aggregates, and the site shall be firm and smooth and well drained. A bed of aggregate suitable to avoid the inclusion of soil or foreign material shall be maintained.
- D. The stockpiles shall be built in layers not exceeding 4 feet in height, and each layer shall be completely in place before the next layer is started so as to prevent segregation. The material shall be deposited in such manner as to prevent coning, except in the case of fine aggregate composed of material approximately 90 percent finer than a #4 sieve.
- E. Dumping, casting, or pushing over sides of stockpiles is prohibited except in the case of fine aggregate materials.
- F. Stockpiles of different types or sizes of aggregates shall be spaced far enough apart or separated by suitable walls or partitions to prevent the mixing of the aggregates.
- G. Any stockpiling of materials derived by wet pit or dredging operations, other than those stockpiles previously mentioned, are subject to prior approval of Engineer and must be specified and submitted in Contractor's plan of operations.
- H. When it is necessary to operate trucks or other equipment on the stockpile in the process of building that stockpile, it should be done in a manner approved by Engineer. Any method of stockpiling aggregate which allows the stockpile to become contaminated with foreign matter or causes excessive degradation of the aggregate will not be permitted. Excessive degradation will be determined by sieve tests of samples taken from any portion of the stockpile over which equipment has operated. Failure of such samples to meet all grading requirements for the aggregate shall be considered cause for discontinuance of such stockpiling procedures.

- I. The aggregate shall be transferred from the stockpiles in such a way as to obtain a material having a uniform grading.

3.02 PROTECTION FOR AGGREGATE

- A. The equipment and methods utilized in the production, storage, transportation, and final placement of aggregate materials shall be such as to provide in-place materials meeting all requirements as specified.

PART 4 METHOD OF MEASUREMENT AND BASIS OF PAYMENT

4.01 METHOD OF MEASUREMENT

- A. Unless otherwise noted in the Special Provisions, no separate measurement will be made for items under this section. Full compensation shall be considered as included in the prices paid for the various contract items and no additional compensation will be allowed.

4.02 BASIS OF PAYMENT

- A. Unless otherwise noted in the Special Provisions, no separate payment will be made for items under this section. Full compensation shall be considered as included in the prices paid for the various contract items and no additional compensation will be allowed.

END OF SECTION

SECTION 02210 — EXCAVATION AND EMBANKMENT

PART 1 GENERAL

1.01 SUMMARY

- A. This work shall consist of excavation, disposal, or compaction of all materials not being removed under some other item, which is encountered within the limits of the work necessary for the construction of the project in accordance with the specifications and in conformity with the lines, grades, thicknesses, and typical cross sections shown in the plans. All excavation will be denoted as borrow excavation, rock excavation, muck excavation, or unclassified excavation as hereafter described.

PART 2 PRODUCTS

2.01 BORROW EXCAVATION

- A. Borrow Excavation shall consist of excavation made from borrow areas within the project limits and outside the normal grading limits for the completion of embankments. Borrow areas or areas within the project limits from which the borrow material may be obtained will be designated on the Plans.
- B. Borrow excavation shall be made only at those designated locations and within the horizontal and vertical limits as stated or directed. On completion of borrow operations, the borrow area will be adequately drained and finished to a neat and uniform grade acceptable to Engineer. Borrow excavation, if required, shall be paid for at the contract unit price bid for "Unclassified Excavation."

2.02 IMPORTED BORROW EXCAVATION

- A. Imported Borrow Excavation shall consist of excavation made from borrow areas outside the project limits and outside the normal grading limits for the completion of the embankments. Borrow areas or areas outside the project pits from which the imported borrow may be obtained will be designated in the contract documents or selected by Contractor. However, any source chosen by Contractor will be subject to the approval of Engineer.
- B. Imported Borrow Excavation, if required, shall be paid for at the contract unit price bid for "Imported Borrow."

2.03 ROCK EXCAVATION

- A. Rock excavation shall consist of the removal and disposal of igneous, metamorphic, and sedimentary rock which cannot be excavated without blasting or using rippers, and all boulders or other detached stones each having a volume of 1/2 cubic yard or more.

2.04 MUCK EXCAVATION

- A. Muck excavation shall consist of the removal and disposal of saturated organic mixtures of soils or organic matter from within the roadway, not associated with culvert installations, which require additional work or equipment which would not normally be required for unclassified excavation. When it is necessary that the muck excavation be stockpiled prior to final placement, classification of the material for the second handling shall be determined by Engineer.

2.05 UNCLASSIFIED ECAVATION

- A. Unclassified excavation shall consist of the excavation and disposal of all material encountered in the work, including excavation obtained from borrow sources, not classified under other items of the contract.

PART 3 EXECUTION

3.01 CONSTRUCTION

- A. All excavation and embankment work shall be constructed to the neat lines and elevations staked by Engineer or shown on the plans. No materials shall be wasted without permission from Engineer. All grading and related operations shall be conducted so that the terrain outside of the limits of slopes will not be disturbed. Prior to the commencement of grading operations, all necessary clearing and grubbing in the area shall have been performed in accordance with Section 02110, CLEARING AND GRUBBING.
- B. When embankments are to be placed on a hillside, or where new fill is to be placed against existing embankment, the slope of the original hillside, or old fill respectively, shall be benched or stepped by cutting into it horizontally, for a minimum distance of 12 inches to provide for secure bonding of the embankment while it is being brought up in layers. Each bench shall be cut as close to the one below as the slope of the ground will permit. Material thus cut out of the benches shall be incorporated into the new fill at Contractor's expense.
- C. If it should become necessary, because of weather or other conditions, to suspend grading operations, the entire area worked upon shall be bladed until smooth, free of depressions and ruts, and crowned so that no water can collect or be impounded.
- D. Embankment placed adjacent to structures shall be brought up in equal layers on all sides to prevent distortion of any of these parts. If is necessary to deposit embankment on only one side of abutments, wing walls, piers, or culvert headwalls, compaction shall be accomplished without causing overturning of or excessive pressure against the structure. Areas inaccessible to tamping rollers or power rollers shall be compacted by hand or mechanical tampers or other means until the density conforms to adjacent embankment, compacted in accordance with these specifications.

- E. Embankment material shall be placed in uniform approximate horizontal layers not exceeding 8 inches in loose thickness, for the entire width of the embankment. Each layer of embankment shall be completed, leveled and compacted before the succeeding layer is placed.
- F. Embankment which has been subjected to freezing shall be refinished to grade, cross-section and compaction requirements after the frost is out of the ground and the embankment is in suitable condition of work.

3.02

MOISTURE AND DESTINY CONTROL

- A. Contractor shall provide watering and rolling as required to obtain the density of 90 percent of maximum dry density for all the embankment placed and no separate pay compensation shall be allowed for rolling and watering other than the earthwork bid item or items listed on the Proposal. In the case of embankment material with Plasticity Indexes greater than zero, as determined by ASTM D-424, the amount of water required for rolling shall be within plus two or minus four percentage points of optimum moisture content as determined by AASHTO T-180, Modified Proctor Density, Maximum densities will be determined by AASHTO T-180, Modified Proctor Density.
- B. Within the areas indicated on the plans or as directed by Engineer, earth shall be removed to the designated depth below subgrade, except for the lower 6-inch layer. This 6-inch layer shall be thoroughly scarified, the moisture content increased or reduced as necessary, and then compacted to not less than 85 percent of the maximum density. The remainder of the area up to subgrade elevation shall be constructed of suitable material compacted to not less than 90 percent of maximum density.

3.03

HAUL

- A. When constructing embankments as specified, or wasting, as the case may be, no haul will be allowed on excavated material as a haul item but shall be included in the contract unit price bid for earthwork item or items listed on the Proposal.

3.04

FINE GRADING

- A. After the earthwork has been substantially completed and after all underground utilities, manholes, catch basins, valve boxes, etc., have been installed or adjusted to grade, the subgrade shall be brought to the lines, grades, and cross-sections shown on the plans, and compacted to the required density.
- B. All soft and unstable material and other portions of the subgrade which, in the opinion of Engineer, cannot be compacted satisfactorily shall be removed to lines and grades as directed by Engineer.

- C. All boulders appearing in the earth excavation shall be removed or broken off to a depth of not less than 4 inches below subgrade. All rock sections shall be brought to grade by depositing a satisfactory cushion material to a depth authorized by Engineer.
- D. If the surface of an old stone or gravel roadbed conforms approximately to the surface of the finished subgrade, such sections shall be scarified superficially for the full width of the subgrade to a depth sufficient to eliminate all depressions and to permit uniform reshaping and compaction.
- E. At all times, ditches and drains along the subgrade shall be so maintained as to drain effectively. When ruts of 2 inches or more in depth are formed, the subgrade shall be brought to grade and if necessary be reshaped and rerolled. In no case shall any surface course or pavement be placed on a frozen or muddy subgrade. The top 6 inches of the subgrade shall have a minimum compacted density as specified for embankment.
- F. In addition, the finish grade shall not deviate more than 1/10 foot at any point from the staked elevation. Until the subgrade has been checked and approved, no surface course or pavement shall be laid thereon. Under the square yard method of measurement and payment Contractor has the option of deviating from the above tolerances as long as the specified base coarse section and profile is maintained.

PART 4 METHOD OF MEASUREMENT AND BASIS OF PAYMENT

4.01 METHOD OF MEASUREMENT

- A. AREA BASIS - UNCLASSIFIED EXCAVATION ABOVE SUBGRADE. This item shall be measured by the square yards of asphalt pavement surface area.
- B. VOLUMETRIC BASIS - UNCLASSIFIED EXCAVATION ABOVE SUBGRADE. This item shall be measured by the number of cubic yards, measured in its original position, computed to the neat lines and grades shown on the plans, except as these lines and grades may be modified in the field by Engineer during construction, with measurement to be made by the method of average end area of material acceptably excavated as herein specified. It shall be specifically understood that the top limit of cross sections for determining end area shall be the top of the existing surface.
- C. EXCAVATION BELOW SUBGRADE. This item shall be measured by the average end area method of calculating cubic yards of material removed.
- D. BORROW EXCAVATION. Borrow Excavation shall be measured by the same method as "Unclassified Excavation Above Subgrade - Cubic Yard Basis."
- E. IMPORTED BORROW EXCAVATION. Imported Borrow Excavation shall be measured by the same method as "Borrow Excavation."
- F. ROCK EXCAVATION. When the plans call for payment to be made under the item rock excavation by volume, the quantity will be computed by the average end area method.

- G. MUCK EXCAVATION. Measurement for muck excavation, when set up on the contract, will be by cross-section. If the material does not meet the requirements for muck excavation, it shall be measured as unclassified excavation.

4.02

BASIS OF PAYMENT

- A. AREA BASIS - UNCLASSIFIED EXCAVATION ABOVE SUBGRADE. This item shall be paid for at the contract unit price bid multiplied by the number of square yards measured as excavated, which price and payment shall constitute full compensation for all labor, equipment, tools and incidentals necessary to accomplish all clearing, grubbing, street and drainage excavation, including excavation for sidewalk, curb and/or combined curb and gutter and grading behind sidewalk, curb and/or combined curb and gutter as shown on the plans; to construct, shape and slope embankments, cuts, subgrades, shoulders, gutters, ditches, street and alley intersections, approaches and private driveway entrances in the locations, to the elevations and according to details shown on the plans; to backfill ditches, depressions and behind sidewalk, curb and/or combined curb and gutter; to remove and to make satisfactory disposal of all unsuitable and surplus materials occurring within the limits of the work; to compact, water and fine grade embankment, backfill and compact areas where unstable material has been removed and all other incidental items and operations to complete this item.
- B. VOLUMETRIC BASIS - UNCLASSIFIED EXCAVATION ABOVE SUBGRADE. This item shall be paid for at the contract unit price bid multiplied by the number of cubic yards measured as excavated, which price and payment shall constitute full compensation for all labor, equipment, tools and incidentals necessary to accomplish all clearing, grubbing, street and drainage excavation, including excavation for sidewalk, curb and/or combined curb and gutter as shown on the plans; to construct, shape and slope embankments, cuts, subgrades, shoulders, gutters, ditches, street and alley intersections, approaches and private driveway entrances in the locations, to the elevations and according to details shown on the plans; to backfill ditches, depressions and behind sidewalk, curb and/or combined curb and gutters; to remove and to make satisfactory disposal of all unsuitable and surplus materials occurring within the limits of the work; to compact, water and fine grade embankment, backfill and compact areas where unstable material has been removed and all other incidental items and operations to complete this item.
- C. EXCAVATION BELOW SUBGRADE. This item shall be paid for by the cubic yards of material removed at the contract unit price bid for "Excavation Below Subgrade" which price and payment shall constitute full compensation for all labor, equipment, tools and incidentals necessary to complete the excavation and disposal of unstable material in embankment foundations and soft or unstable material in the subgrade. The cost of backfilling and compacting holes created by the removal of unstable material shall be included in "Unclassified Excavation Above Subgrade."

- D. BORROW EXCAVATION. This item shall be paid for by the same method as "Unclassified Excavation Above Subgrade - Cubic Yard Basis".
- E. IMPORTED BORROW EXCAVATION. This item shall be paid for by the same method as "Unclassified Excavation Above Subgrade - Cubic Yard Basis".
- F. ROCK EXCAVATION. This item shall be paid for by the same method as "Unclassified Excavation Above Subgrade - Cubic Yard Basis".
- G. MUCK EXCAVATION. This item shall be paid for at the contract unit price bid multiplied by the number of cubic yards measured as excavated.

END OF SECTION

SECTION 02220 — TRENCH EXCAVATION

PART 1 GENERAL

1.01 SUMMARY

- A. This section consists of excavation and trenching for pipelines, handling and storage of materials and preparation of subgrade, pumping and dewatering as necessary, and dressing and surface restoration cleanup of the site.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 CONSTRUCTION

- A. During excavation, materials suitable for backfilling shall be piled in an orderly manner a sufficient distance from the banks of the trench to avoid overloading and to prevent slides or cave-ins. Excavated material shall be piled on one side of the trench only, to permit ready access to existing fire alarm boxes, fire hydrants, valves, manholes and other appurtenances. Surface drainage of adjoining areas shall be unobstructed.
- B. All excavated materials not required or suitable for backfill shall be removed from the site and disposed of in a manner and/or by methods acceptable to jurisdictional government agencies. Engineer may require certification of proper disposal procedures.
- C. Grading shall be done as may be necessary to prevent surface water from flowing into excavations, and any other water accumulating therein shall be promptly removed. Under no circumstances shall water be permitted to rise in unbackfilled trenches until after the pipe has been placed, tested and covered to final grade with backfill. Any pipe having its alignment or grade changed as a result of a flooded trench shall be relayed at no additional cost to Owner.
- D. Adequate provisions shall be made for maintaining the flow of sewers, drains and water courses encountered during construction. Culverts, ditches, fences, crosswalks and structures which are disturbed by this construction shall be satisfactorily restored to their original condition upon completion of the work.

3.02 SITE CONDITIONS

- A. CONTRACTOR'S SAFETY RESPONSIBILITIES
1. Contractor shall be responsible for enforcing safety and maintaining safe working conditions in all trenching, shoring, and blasting operations to conform to OSHA regulations.
 2. Contractor shall employ qualified, properly trained personnel to design shoring, perform safety inspections of the trenches, and supervise the handling of

explosives and other operations involving safety procedures, as prescribed by OSHA.

3.03 TRAFFIC CONTROL AND WARNING DEVICES

- A. Contractor shall plan and construct the project in such a manner as to minimize the interruption of the use of roads, highways, streets, and sidewalks involved and shall provide for emergency access to adjacent property and fire hydrant access at all times.
- B. Contractor is responsible for providing and maintaining adequate barricades of high visibility design, flares, lanterns, signs, flaggers and prewarning devices to alert the public, motorists and pedestrians of hazardous conditions in accordance with the latest edition of the Manual on Uniform Traffic Control Devices for Streets and Highways published by the U.S. Department of Transportation. Work shall also be done in accordance with the Manual on Uniform Traffic Control Devices for Work Zone Areas.
- C. Contractor shall submit his traffic control plan to the local government officer having authority.

3.04 STRUCTURES

- A. Contractor shall exercise every precaution to prevent damage to existing buildings or structures in the vicinity of his work. In the event of such damages, he shall repair them to the satisfaction of Owner of the damaged structure and at no cost to Owner.

3.05 OVERHEAD UTILITIES

- A. Contractor shall use extreme caution to avoid a conflict, contact or damage to overhead utilities, such as power lines, streetlights, telephone lines, television lines, poles or other appurtenances during the course of construction of this Project.

3.06 SURVEY MARKERS AND MONUMENTS

- A. Contractor shall use every care and precaution to protect and not disturb any survey marker or monuments, such as those that might be located at lot or block corners, property pins, intersection of street monuments or addition line demarcation. Such protection shall include marking with flagged high lath and close supervision. No monuments shall be disturbed without prior approval of Owner and Engineer. Any survey marker or monument that is disturbed or destroyed by Contractor without approval during the construction of this Project shall be replaced at no cost to Owner by a licensed land surveyor.

3.07 CLEANUP

- A. As work progresses, that portion of the work completed shall be cleared of debris and brought to the finished grade. Upon completion of the work, the entire site shall be cleared of all debris and ground surfaces shall be finished to smooth, uniform slopes

and shall present a neat and workmanlike appearance. All rocks brought to the ground surface by excavation or backfilling operations shall be removed.

- B. At all times during construction, Contractor shall be responsible for dust control as directed by Engineer.

3.08 TRENCH EXCAVATION

- A. Trench excavation shall be performed in accordance with minimum requirements of Wyoming State OSHA Regulations.

3.09 PREPARATION

A. PROTECTION OF EXISTING PROPERTIES

1. Prior to beginning construction, Contractor must fulfill and meet the requirements of Wyoming Statutes 37-12-301 through 37-12-304 relating to public utilities; providing definitions; providing that notice of intended excavation be given to public utilities with underground facilities located in the area of proposed excavation; and providing for exceptions.
2. Existing utilities which will intersect with the new pipelines or structures will be relocated by Contractor.
3. Existing water or sewer services from the mains to private property which interfere with trenching operations may be cut and replaced at Contractor's expense. The use of such services shall in no case be interrupted for more than 4 hours, unless temporary service is provided.
4. Existing water mains and water services shall be protected at all times during construction operations.

3.10 PRIVATELY OWNED UTILITIES

- A. Gas mains, underground electrical and telephone cables, telephone poles, light poles, etc., required to be moved to make way for new construction will be moved by others. Contractor shall assure that all necessary arrangements are made with the appropriate utility Owner(s) prior to beginning work in the affected area, and he shall assure that all required work is coordinated with the appropriate utility Owner(s) as work progresses.

3.11 EXPLORATORY EXCAVATION

- A. Location of buried utilities that might interfere with alignment or grade shall be verified by exploratory excavation prior to construction. If any existing utility interferes with the work in either alignment or grade and has to be moved, such work shall be done by Contractor.

3.12 SHORING, SHEETING AND BRACING

- A. Contractor shall do all shoring, bracing and tight sheeting required to prevent caving and to protect their worker, in accordance with Occupational Safety and Health Regulation Requirements, and to protect adjacent property and structures.

3.13 DEWATERING

- A. Where ground water is encountered in excavation, it shall be removed to avoid interfering with pipe laying and other construction operations. The cost of dewatering operations will not be paid as a separate item but shall be merged with and considered a part of the excavation costs unless otherwise addressed in the contract documents.
- B. Discharge from dewatering operations shall be directed to approved natural drainages or storm sewers as appropriate.
- C. Discharge from dewatering operations shall be in accordance with rules and regulations established by the Wyoming Department of Environmental Quality. These activities require coverage under an NPDES permit. The Wyoming Department of Environmental Quality (DEQ) has issued a general permit for temporary discharges. The general permit for temporary discharges currently authorizes the discharge of wastewaters to surface waters of the state associated with hydrostatic testing of pipes, tanks or other similar vessels, disinfection of potable water lines, pump tests of water wells, or construction dewatering.
- D. If dewatering is necessary, Contractor shall be responsible for completing and submitting a "Notice of Intent" (NOI) to the Wyoming Department of Environmental Quality, as the applicant, and complying with the effluent limitations and monitoring requirements. The DEQ will review the NOI and determine if the proposed activity is eligible for coverage under this permit or if the activity must be covered under an individual permit. If the proposed activity is eligible for coverage under the general permit, the DEQ will send Contractor notification, through a written facility certification form, that coverage has been granted. The facility certification form will also establish effluent limitations and monitoring requirements.
- E. Effluent associated with construction dewatering.

PARAMETER	EFFLUENT LIMITATION	FREQUENCY	SAMPLE TYPE
Flow, gpm	N/A	Daily	Instantaneous or Continuous
Total suspended solids, mg/L	The concentration shall not exceed a monthly average of 30mg/L, a weekly average of 45mg/L, or a daily maximum of 90mg/L.	Weekly	Grab
pH, s.u.	The p.H. shall not be less than 6.5 nor more than 9.0 standard units.	Daily	Grab
Oil and Grease	The concentration shall not exceed 10mg/L.	Daily	Visual
Turbidity	A discharge to Class 2 water shall not result in a turbidity net increase of 10 nephelometric turbidity units (NTUs). A discharge to Class 2ww or Class 3 waters shall not result in a turbidity net increase of 15 NTUs.	Daily	Grab

3.14**GENERAL EXCAVATION OPERATIONS**

- A. Contractor shall excavate as necessary at the locations shown on the drawings, staked in the field or otherwise specified for the installation of pipelines.
- B. Contractor shall take precautions and protect all adjoining private and public property and facilities, including underground and overhead utilities, curbs, sidewalks, driveways, structures, and fences. Any disturbed or damaged facilities will be suitably restored or replaced by Contractor.
- C. Crossings under sidewalks or curbs may be made by tunneling only if approved by Engineer. If Contractor elects to remove a portion of the sidewalk or curb, he must use a concrete saw for making neat joints corresponding to existing joints, compact the backfill as specified, and pour a new concrete sidewalk or curb section.
- D. EXCAVATION FOR APPURTENANCES
 - 1. Excavations for manholes, hydrants, structures and other appurtenances shall be sufficient to leave clearance adequate for proper compactive effort on all sides. The depth, provisions for removing water, and other applicable portions of these specifications shall apply to excavation for appurtenances.

3.15**TRENCH DIMENSIONS**

- A. Trench dimensions shall be as specified below:
 - 1. Trench width FROM the trench bottom to a point 1 foot above the top of the pipe shall be no less than the outside diameter of the pipe plus 12 inches, but not more than 24 inches plus the pipe outside diameter. The width of the trench from the bottom of the trench to the existing ground surface shall be adequate to allow proper compactive effort along both sides of the pipe.
 - a. Depth of Trench. Trench depth shall be as required for the invert grade or pipe bury shown on the plans. Care shall be taken not to excavate below the required depth.
 - b. When soft or unstable material or rock is encountered at the subgrade which will not uniformly support the pipe, such material shall be excavated to an additional depth as necessary and backfilled with Type 2 Bedding Material.
 - 2. TRENCH BOTTOM
 - a. The bottom of the trenches shall be accurately graded to the line and grade shown on the drawings. Bedding material shall provide uniform bearing and support for each section of the pipe at every point along its entire length. Bell holes and depressions for joints shall be dug after the trench bedding has been graded, and shall be only of such length, depth and width as required for properly making the particular type of joint. Unauthorized over depths shall be backfilled with bedding material at Contractor's expense.

3.16 **TIME OF OPEN TRENCHES**

- A. Contractor will be required to conduct his work so that trenches will remain open a minimum possible time.
- B. No trench excavating shall begin until approved compaction equipment is at the site where the excavating is to take place. All backfill and compacting shall be completed in all trenching and structural excavations within a maximum distance of 500 feet behind the end of newly installed pipe and the maximum distance between the newly installed pipe and the excavator shall be 200 feet. For each work group consisting of trench excavator, a pipe-laying crew, and a backfilling and compacting crew, the maximum allowable open ditch at any time will be 400 feet.
- C. Certain conditions may necessitate the closing of certain sections of trench prior to daily, weekend or holiday shutdown.

3.17 **EQUIPMENT**

- A. The use of trench digging machinery will be permitted except in places where its operation will cause damage to existing structures or features, in which case hand methods shall be employed.
- B. Any equipment on tracks, which is to be used on pavement, shall be equipped with suitable pads to prevent damage to the pavement. All pavement damaged during construction by Contractor's equipment shall be restored to its original condition by Contractor.

PART 4 **METHOD OF MEASUREMENT AND BASIS OF PAYMENT**

4.01 **METHOD OF MEASUREMENT**

- A. No separate measurement will be made for items under this section.

4.02 **BASIS OF PAYMENT**

- A. No separate payment will be made for items under this section. Full compensation shall be considered as included in the prices paid for the various contract items and no additional compensation will be allowed.

END OF SECTION

SECTION 02222 — ROCK EXCAVATION

PART 1 GENERAL

1.01 SUMMARY

- A. This section consists of requirements for rock removal and the use of explosives to assist in rock removal.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 CONSTRUCTION

- A. Blasting for excavation will be permitted only after securing the approval of Engineer, and the hours of blasting will be fixed by Engineer. Contractor shall use utmost care to protect life and property. All explosives shall be safely and securely stored in compliance with local laws and ordinances, and all such storage places shall be clearly marked "Dangerous Explosives". No explosives shall be left unprotected where they could endanger persons or property.
- B. When blasting rock in trenches, Contractor shall cover the area to be shot with earth backfill or approved blasting mats that will prevent the scattering of rock fragments outside the excavation. Prior to blasting, Contractor shall station men and provide signals of danger in suitable places to warn people and stop vehicles. Contractor will be responsible for all damage to property and injury to persons resulting from blasting or accidental explosions that may occur in connection with his use of explosives.
- C. Contractor shall furnish the following information to Owner and Engineer prior to commencing blasting operations: Name of his powder man, powder man's experience, type of shot, type of explosives and detonator being used, proof of insurance covering liability for such operation, traffic control plans and planned procedures for protecting the public.
- D. Contractor's blasting procedures shall conform to Federal, State, and local ordinances. Contractor shall acquire all required permits prior to the start of blasting.

PART 4 METHOD OF MEASUREMENT AND BASIS OF PAYMENT

4.01 METHOD OF MEASUREMENT

- A. Unless otherwise noted in the special provisions, no separate measurement will be made for items under this section.

4.02 BASIS OF PAYMENT

- A. There will be no differentiation between common and rock trench excavation, except when listed as separate items on the bid proposal or bid form. Excavation shall include the removal and subsequent handling of all earth, gravel, rock or other material

encountered regardless of the type, character, composition or condition of the material. Full compensation shall be considered as included in the prices paid for the various contract items and no additional compensation will be allowed.

END OF SECTION

SECTION 02225 — TRENCH BACKFILL

PART 1 GENERAL

1.01 SUMMARY

- A. This section consists of handling and storage of materials to be used for fill and backfill, and final grading.

PART 2 PRODUCTS

2.01 MATERIALS

A. PIPE BEDDING MATERIAL

1. Type 1 Bedding material around the pipe from 6 inches under the pipe to 12 inches over the pipe shall consist of select coarse-grained soils, with less than 5 percent passing a #200 sieve, such as gravel, sand, or silty sand meeting unified soil classification requirements as per ASTM designation D-2487 for type GW, GP, GM, GC, SW, SP, SM & SC, or as specifically approved by Engineer. Bedding material shall not consist of silt, clay & organic soils meeting requirements for soil types ML, CH, & PT. Bedding material shall be free from clods, frozen material, or stones larger than 3/4 inch in their maximum dimension. Where wet or otherwise unstable conditions exist, the material in this zone shall be free draining, non-plastic material. Where suitable material is available in the material excavated from the trench, Contractor may procure the select material by screening, sifting or manually sorting the material removed from the trench in a manner approved by Engineer. Depth of bedding material shall be specified under Standard Drawing No. 02220-01, or as revised in the Special Revisions and/or Drawings.
2. Type 2 Pipe Bedding is required for foundation in over-excavated trenches and shall consist of the bedding material from the bottom of the Type 1 Bedding material and below. The bedding material shall consist of sand, sandy gravel, compacted rock or gravel having a maximum size of 1-1/2 inches, uniformly graded and having a maximum plasticity of 6 as determined by AASHTO Methods T-89 and T-90.

B. CEMENT TREATED FILL

Cement treated fill, when specified, shall meet the following criteria:

Ingredients	Lbs/C.Y.
Cement (0.45 sack)	42 lbs.
Water (39 gallons)	325 lbs.
Coarse aggregate (Size No. 57)	1700 lbs.
Sand (ASTM C-33)	1845 lbs.

The maximum desired 28 day strength is from 30 to 60 psi.

Other cement treated fill designs may be submitted to Engineer for review and approval.

PART 3 EXECUTION

3.01 CONSTRUCTION

A. COMMON AND SELECT BACKFILL

1. All trenches shall be backfilled immediately after grade, alignment and jointing of the pipe has been inspected and approved. Leakage tests, pressure tests or tests for alignment and grade shall be performed after backfill. If any test fails, Contractor shall be responsible for work required to correct the defects.
2. After the select pipe bedding material has been placed and compacted as specified in Subsection 3.02.A., the remainder of the trench backfilling shall be done. All backfill material shall be free from cinders, ashes, refuse, organic and frozen material, boulders, or other materials that are unsuitable. From the top of the pipe bedding to 6 inches below the ground surface, or to the subgrade elevation for streets or paved surfaces, material containing stones up to 3 inches in the greatest dimension may be used. No material over 3 inches in any dimension is allowed within 24 inches of the pipe.
3. Trench backfill from the top of the pipe bedding material to ground surface or to the subgrade of street surfacing is separated into two classifications. Type A trench backfill refers to compacted backfill in streets, paved areas, or alleys. Type B backfill is designated for fields, borrow pits, unimproved streets, or other unsurfaced areas where special compaction of the trench backfill is not required. Locations of the types of backfill required shall be as shown on the plans.
4. Where shown on the plans, Contractor shall provide embankment over the pipe above the original ground surface to a height which will satisfy the minimum depth of cover requirements. Such embankment shall be constructed to the cross section shown on the plans.

B. TYPE A TRENCH BACKFILL

1. Materials used for bedding and backfill shall be carefully deposited in depth layers suitable to the equipment used for compaction, wetted to 3 percent below to 2 percent above optimum moisture content, and compacted to at least 96 percent of maximum density as determined by AASHTO T-99 (Standard Proctor).
2. Compaction by flooding will not be permitted.
3. If the backfilled trench has not been tested at required intervals during backfilling, Contractor shall provide excavation equipment to dig compaction test holes through each layer of backfill. Compaction tests shall be required for each one foot layer of backfill at linear intervals not to exceed 200 feet whether tests are performed during backfilling or via test holes. Should tests fail, Contractor shall

remove all trench backfill above the failed lift and rework to passing compaction the area of deficiency. Engineer shall determine the area of deficiency. In no case shall it extend into areas of known acceptable compaction. All work required to bring the failed test area into spec shall be at Contractors expense. Passing backfill tests only assures Owner that the minimum acceptable level of testing was achieved. The passing tests do not relieve Contractor of his responsibility to compact the entire trench and does not relieve his guarantee of the trench as identified in this specification.

4. For graveled streets and alleys, the backfill shall be completed by blading the stripped gravel back over the trench.
5. Each service line shall be backfilled and compacted to the same requirements as the main line trench. Each service must have at least one passing compaction test.

C. TYPE B TRENCH BACKFILL

1. Materials used for Type B Trench Backfill shall not require special compaction. The material shall be compacted in layers to achieve a density approximately equal to the density of the existing soil.
2. Contractor may be required to mound excess earth over the top of the trench so that a depression will not be formed after the trench settles. In cultivated areas, the stripped topsoil shall be placed uniformly over the backfilled trench. The topsoil shall not be compacted but shall be graded to provide a smooth surface conforming to the adjoining ground surfaces.

3.02

COMPACTION

- A. Bedding material under and around the pipe to 12 inches above the top of the pipe shall be distributed by hand in maximum layers of 6 inches and thoroughly compacted by tamping. Special care shall be taken to assure complete compaction under the haunches of the pipe.
- B. Backfill material shall be placed in the trench for its full width on each side simultaneously. Compaction of pipe bedding shall be in accordance with this specification.
- C. Cement treated fill may be used for backfill used at the option of Contractor. Provided it meets or exceeds the requirements set forth, no specific compaction will be required.
- D. Cement treated fill may be used at the option of Contractor provided it meets the requirements of Engineer. Engineer may require certification of mix design and batching ingredients.

3.03 TESTING

- A. Field density testing of compacted fill will be run at all levels. These tests will be performed by a reputable testing firm at the discretion of Engineer and hired and approved by Owner. Contractor shall provide necessary equipment to dig test holes. Contractor shall be responsible for correction of any areas failing compaction tests, and the expense of such correction shall be borne by Contractor.

3.04 TRENCH GUARANTEE

- A. Contractor shall, for a period of 1 year after completion and final acceptance of the work, repair any trench settlement which may occur and shall make suitable repairs to any pavement, sidewalks or other structures which may become damaged as a result of backfill settlement.
- B. If Contractor elects to perform such repairs by subcontract with Owner or with others, he shall furnish Owner and Engineer a copy of such subcontract or authorization as evidence of his faithful intention to perform the work.

PART 4 METHOD OF MEASUREMENT AND BASIS OF PAYMENT

4.01 METHOD OF MEASUREMENT

- A. No separate measurement will be made for items under this section. Full compensation shall be considered as included in the prices paid for the various contract items and no additional compensation will be allowed.

4.02 BASIS OF PAYMENT

- A. No separate payment will be made for this section. Full compensation shall be considered as included in the prices paid for various contract items and no additional compensation will be allowed.

END OF SECTION

SECTION 02226 — BACKFILLING FOR APPURTENANCES

PART 1 GENERAL

1.01 SUMMARY

- A. This section consists of backfilling for appurtenances.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

- A. Backfill around appurtenances shall be deposited in such a manner as not to disturb the appurtenance from its proper alignment and compacted to the finished grade. Backfill material, compaction and backfill procedures shall conform to the requirements of the related Type A or Type B backfill as specified for trenches.

PART 4 METHOD OF MEASUREMENT AND BASIS OF PAYMENT

4.01 METHOD OF MEASUREMENT

- A. Unless otherwise noted in the special provisions, no separate measurement will be made for items under this section.

4.02 BASIS OF PAYMENT

- A. Unless otherwise noted in the special provisions, no separate payment will be made for items under this section. Full compensation shall be considered as included in the prices paid for the various contract items and no additional compensation will be allowed.

END OF SECTION

SECTION 02227 — BACKFILLING FOR PAVEMENT

PART 1 GENERAL

1.01 SUMMARY

- A. This section consists of backfilling and compacting operation for construction or reconstruction of roadways, embankments, streets, parking lots and other paved surface areas.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 CONSTRUCTION

- A. Surfaces for trenches in paved streets or alleys shall be restored to their original shape and the surfacing material shall be of equal quality and equal thickness to that of the original surface. Surfacing material shall be approved by Engineer. Care shall be taken not to contaminate existing surfaces outside the trench area.
- B. Subgrade for trench pavement resurfacing shall be prepared per Sections 02511, ROAD MIX AND BITUMINOUS PAVEMENTS, and 02520, PORTLAND CEMENT CONCRETE PAVEMENT, as applicable.

PART 4 METHOD OF MEASUREMENT AND BASIS OF PAYMENT

4.01 METHOD OF MEASUREMENT

- A. Unless otherwise noted in the special provisions, no separate measurement will be made for items under this section.

4.02 BASIS OF PAYMENT

- A. Unless otherwise noted in the special provisions, no separate payment will be made for items under this section. Full compensation shall be considered as included in the prices paid for the various contract items and no additional compensation will be allowed.

END OF SECTION

SECTION 02231 — AGGREGATE SUB-BASE AND BASE COURSES

PART 1 GENERAL

1.01 SUMMARY

- A. This work shall consist of furnishing and placing one or more courses of aggregate and additives, if required, on a prepared surface in accordance with these specifications and in reasonably close conformity with the lines, grades, thickness, and typical cross sections shown on the plans or established by Engineer.

1.02 RELATED WORK

- A. Section 02190, Aggregates
- B. Section 02210, Excavation and Embankment
- C. Section 02227, Backfilling for Pavement
- D. Section 02895, Engineering Fabric

1.03 REFERENCES

- A. ASTM C911: Quicklime, Hydrated Lime and Limestone for Selected Chemical and Industrial Uses
- B. AASHTO M85: Portland Cement
- C. AASHTO T99: Standard Method of Test for Moisture-Density Relations of Soils using a 5.5-lb. Rammer and a 12-inch Drop (Standard Proctor)
- D. AASHTO T180: Standard Method of Test for Moisture-Density Relations of Soils Using a 10-lb. Rammer and an 18-inch Drop (Modified Proctor)
- E. AASHTO T191: Standard Method of Test for Density of Soil In-Place by the Sand Cone Method (Wyoming Modified)

1.04 SUBMITTALS

- A. When the stationary plant method is used, the aggregate will be accepted immediately before mixing and prior to the addition of water based on periodic samples taken from the pug mill input.
- B. When a road mix method is used, the aggregate will be accepted after necessary blending and before laying, based on samples taken from the combined windrow for each lift.

PART 2 MATERIALS

2.01 MATERIALS

- A. The aggregates shall meet the requirements of Section 02190, AGGREGATES.

- B. Stockpiled materials shall meet the requirements of Section 02190, Subsection 3.01, STOCKPILED AGGREGATE.
- C. Commercial additives, when required, shall meet the following requirements:
 - 1. HYDRATED LIME - Hydrated lime shall conform to the requirements of ASTM C 911.
 - 2. PORTLAND CEMENT - Portland Cement shall conform to the requirements of AASHTO M 85. Unless otherwise designated or permitted, Types I or II shall be used.
 - 3. FLY ASH - Fly ash shall conform to the requirements of ASTM C311 and ASTM C618 for either Class C or F, as specified in the Contract Documents. Aggregates determined to be reactive shall require the use of ASTM C 618, Table 3.
- D. Unless otherwise permitted by Engineer, the product of only one mill for any one brand and type of portland cement shall be used on the project.
- E. Contractor shall provide suitable means for storing and protecting the additives against dampness and other forms of damage. Cement additives which, for any reason, have become partially set or which contain lumps of caked cement shall be rejected. Cement additives may not be salvaged from discarded or used bags.
- F. Other additives, when specified, shall meet the requirements set forth in the Special Provisions.

PART 3 EXECUTION

3.01 PREPARATION

- A. Contractor shall mix the aggregate, water, and commercial additive by the Stationary Plant Method unless otherwise specified by Engineer in the Special Provisions.
- B. The Stationary Plant Method shall meet the following requirements:
 - 1. The aggregate and water shall be mixed in an approved pug mill mixer. Water shall be added during the mixing operation in the amount necessary to maintain the required moisture content for compacting.
- C. The mixer shall be capable of uniformly distributing the aggregate, additives, and water throughout the mixture without evidence of over-wet or dry pockets.

3.02 APPLICATION

- A. Stationary Plant Method - Materials mixed by the stationary plant method shall be transported to the job site while it contains the proper moisture content, and shall be placed on the roadbed by means of an approved method.
- B. Travel Plant Method - After the material for each layer has been placed through an aggregate spreader, windrow sizing device or aggregate hopper, the material shall be

uniformly mixed by a traveling mixing plant. During mixing, water shall be added in an amount sufficient to maintain the required moisture content for compacting.

- C. Road Mix Method - After material for each layer of the course has been placed, the materials shall be mixed while in the range of plus 2% or minus 4% of optimum moisture content, by means of motor graders or other approved equipment until the mixture is uniform throughout.
- D. Stockpile Method - Commercial additives, if required, will be introduced into the aggregate during stockpiling operations. Water will be introduced by pre-wetting the stockpile of aggregate and additive. Additional water may have to be introduced during the placing of the aggregate courses.

3.03 SHAPING AND COMPACTION

- A. The moisture content of the material at the time of compaction shall be within plus two or minus four percentage points of optimum.
- B. If the required compacted depth of sub-base course exceeds 6 inches, the course shall be constructed in 2 or more layers of approximately equal thickness. The maximum compacted thickness of any one layer shall not exceed 6 inches. When vibrating or other approved types of special compacting equipment are used, the depth of a single layer of the course may be increased upon approval by Engineer.
- C. Each layer shall be compacted to a density of not less than 95 percent of maximum density as determined in accordance with AASHTO T 180, unless otherwise noted in the Special Provisions. Compactions or in-place field densities will be determined by AASHTO T 191 (Wyoming Modified), or by other approved methods. The surface of each layer shall be maintained during compaction operations in such manner that a uniform texture and surface is produced and the aggregates firmly keyed. Water shall be uniformly applied over the materials during compaction in the amount necessary for proper consolidation.

PART 4 METHOD OF MEASUREMENT AND BASIS OF PAYMENT

4.01 METHOD OF MEASUREMENT

- A. Aggregate base and sub-base courses will be measured by the cubic yard, compacted in place.

4.02 BASIS OF PAYMENT

- A. The accepted quantities of Aggregate Sub-base and Base Course of size specified will be paid for at the contract prices per cubic yard for aggregate sub-base, base course, and additives, complete in place. Payment includes reuse of existing material or supplying new material, stockpiling, scarifying substrate surface, placing where required, and compacting, with moisture and density control. Payment also includes hauling and delivery of material, as well as water necessary for moisture control. Payment will be made under:

PAY ITEM	PAY UNIT
Crushed Base	Cubic Yard
Pit Run Sub-base	Cubic Yard
Crusher Run Sub-base	Cubic Yard
Crushed Sub-base	Cubic Yard
Sub-base	Cubic Yard
Pit Run Base	Cubic Yard
Crusher Run Base	Cubic Yard
Commercial Additives	Cubic Yard

END OF SECTION

SECTION 02273 — RIPRAP

PART 1 GENERAL

1.01 SUMMARY

- A. This work shall consist of the bank or watercourse protection courses in accordance with these specifications and in reasonably close conformity with the lines, grades, and thickness shown on the plans or established by Engineer.

1.02 RELATED WORK

- A. Section 02190, Aggregates
- B. Section 02210, Excavation and Embankment
- C. Section 02895, Engineering Fabric
- D. Section 03600, Grout

1.03 REFERENCES

- A. ASTM A116: Metallic-Coated, Steel-Woven Wire Fence Fabric
- B. ASTM A975: Double-Twisted Hexagonal Mesh Gabions and Revet Mattresses (Metallic-Coated Steel Wire or Metallic-Coated Steel Wire With Poly(Vinyl Chloride) (PVC) Coating)
- C. ASTM C881: Epoxy-Resin-Base Bonding System for Concrete.

1.04 SUBMITTALS

- A. Wire and wire hardware shall be accepted based upon the Manufacturer's Certificate of Compliance.

1.05 DEFINITIONS

- A. Class 1 Riprap - hand placed stones on earth or gravel bedding.
- B. Class 2 Riprap - machine placed stones on earth or gravel bedding.
- C. Grouted Riprap - Class 1 or 2 Riprap as described above with voids filled with sand-cement grout.
- D. Wire Enclosed Riprap - stones placed in wire fabric enclosures.
- E. Sacked Concrete Riprap - hand-placed sacked concrete.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Aggregates used for riprap shall meet the requirements of Section 02190, AGGREGATES.

- B. Wire for wire enclosed riprap shall meet the following requirements unless otherwise noted in the Special Provisions:
 - 1. Woven wire shall be 2- by 4-inch V-mesh fabric having 12-1/2 gauge horizontal wires of 2-strand, twisted construction and 12-1/2 gauge cross wires. All wire shall meet the requirements of ASTM A 116 and shall be Class 1 or better.
 - 2. Lacing and tie wire shall be galvanized, 12-1/2 gauge smooth steel wire. In lieu of lacing, 9 gauge galvanized hog rings at 4-inch spacing may be used for fastening ends, sides, and top panels.
- C. Anchorage for Wire Enclosed Riprap shall meet the following requirements unless otherwise noted in the Special Provisions:
 - 1. Steel stakes may be crane rails, 3-inch nominal standard pipe, or 4- by 4- by 3/8-inch angles or other approved materials as shown on the Drawings or otherwise noted in the Contract Documents. Stakes shall not be less than 5 feet in length.
 - 2. Used materials are acceptable provided that the material is not rusted or damaged to an extent that would affect the strength of the stake.
- D. Grout for grouted riprap shall consist of one part portland cement and three parts of sand, thoroughly mixed with water to produce a workable mix or as otherwise specified in the Contract Documents.
- E. Sacks for sacked concrete riprap shall be made of at least 10-ounce burlap or other approved materials as shown on the Drawings or otherwise noted in the Contract Documents. Sacks shall be approximately 19-1/2 inches by 36 inches measured inside the seams when the sack is laid flat, with an approximate capacity of 1.25 cubic feet. Sound reclaimed sacks may be used.
- F. Concrete for sacked concrete riprap shall consist of a mixture of not less than 4 sacks (376 pounds total weight) of portland cement per cubic yard and sufficient water to obtain a slump of 3 inches to 5 inches or as otherwise specified in the Contract Documents.

PART 3

EXECUTION

3.01

PREPARATION

- A. Slopes on which the riprap is to be placed shall be shaped to allow the full thickness of the specified riprap and any bedding or filter gravel, where required. The slopes shall not be steeper than the natural angle of repose of the slope as shown on the plans or directed. Whenever possible, the excavation shall be undisturbed material or, where this is not possible, the underlying material shall be compacted to at least 90 percent of maximum at optimum moisture content in accordance with the applicable provisions of Section 02225.

- A. When called for on the Drawings or otherwise specified in the Contract Documents, a layer of filter gravel shall be placed on the slope immediately prior to placement of the riprap stone. The layer shall be shaped to provide the minimum thickness specified. The surface should generally fit the bottom surface of the riprap.
- B. At the completion of slope protection work, the footing trench shall be filled with excavated material and compaction will not be required.
- C. Class 1 riprap shall meet the following requirements:
 - 1. The larger stones shall be placed first with close joints.
 - 2. The largest stones shall be placed in the footing trench.
 - 3. Stones shall be placed with their longitudinal axis normal to the embankment face and arranged so that each rock above the foundation course has a 3-point bearing on the underlying stones. The foundation course is the course placed on the slope in contact with the ground surface. Bearing on smaller stones which may be used for chinking voids will not be acceptable. Placing of stones by dumping will not be permitted. Interstices shall be as nearly filled as practicable with smaller stones and spalls.
- D. Class 2 riprap shall meet the following requirements:
 - 1. Stones shall be so placed as to provide a minimum of voids, and the larger stones shall be placed in the toe course and on the outside surface of the slope protection.
 - 2. The stones may be placed by dumping and may be spread in layers by bulldozers or other suitable equipment.
- E. WIRE ENCLOSED RIPRAP
 - 1. Wire enclosed segments shall be hand or machine formed to the dimensions shown on the plans. Enclosure segments shall be placed, laced, and filled in a skillful manner to provide a uniform, dense, protective coat over the area specified.
- F. GROUTED RIPRAP
 - 1. Clean stone shall be placed on the slope in accordance with the class specified. After the stone has been placed, it shall be drenched or sprinkled with water until the stone is thoroughly moistened. The mixed grout shall be applied while the stone is still moist. During application, the grout shall be worked into the interstices to completely fill the voids with grout.
 - 2. Where the depth specified for grouting is in excess of 12 inches, such as in cut-off walls, the riprap stone shall be placed in 12-inch lifts, or as otherwise specified in

the Contract Documents. Each lift shall be grouted prior to placement of the next lift. The succeeding lifts shall be constructed and grouted before the grout in the previous lift has set.

3. Grout shall be placed only when the weather is suitable for such work and shall be protected from freezing for at least 4 days if frost is imminent. The surface of grouted riprap shall be covered with moist earth or wet burlap for not less than 3 days after placing to allow the grout to properly cure.

3.03 ACCEPTANCE

- A. Sampling of materials shall be in accordance with standard material sampling practices unless otherwise specified in the Contract Documents.
- B. At the direction of Engineer, wire and wire products used on the project which do not meet the specification requirements for the type of material specified may:
 1. Be rejected and Contractor required to remove and replace all of the out-of-specification material at his expense;
 2. Be accepted and left in place and Contractor's cost of the wire product deducted; or,
 3. Be accepted at a reduced unit price.

PART 4 METHOD OF MEASUREMENT AND BASIS OF PAYMENT

4.01 METHOD OF MEASUREMENT

- A. Class 1 Riprap, Class 2 Riprap, Grouted Riprap, and Filter Gravel will be measured by the cubic yard in place.
- B. Wire enclosed riprap will be measured by the square yard of top surface area.
- C. Excavation and backfill unless included under some other item, grouting materials, hauling, placing, or shaping, and other incidentals necessary for the completion of the work will not be measured for payment, but will be considered as subsidiary to other items of the contract.

4.02 BASIS OF PAYMENT

- A. The accepted quantities of riprap and filter gravel will be paid for at the contract unit price per cubic yard or square yard, complete in place. Payment will be made under:

PAY ITEM	PAY UNIT
Riprap, Class	Cubic Yards
Wire Encl. Riprap	Square Yards
Grouted Riprap, Class	Cubic Yards
Filter Gravel	Cubic Yards

END OF SECTION

SECTION 02280 — TOPSOIL

PART 1 GENERAL

1.01 SUMMARY

- A. This work shall consist of excavating and depositing topsoil in accordance with the specifications and in reasonably close conformity with the lines, grades, thicknesses, and typical cross-section shown on the plans or established. Removing and stockpiling topsoil prior to grading operations shall be classified as "Unclassified Excavation."
- B. "Unclassified Excavation" shall consist of the excavation and disposal of all materials encountered in the work, including excavation obtained from borrow sources, not classified under other items of the contract.
- C. The item "Topsoil Borrow" will apply only to borrow material obtained from borrow areas and placed directly in its final location. When topsoil is obtained from borrow areas and stockpiled for later use in the work the first handling will be classed as "Unclassified Excavation" and measured and paid for in accordance with Section 02210, EXCAVATION AND EMBANKMENT.

PART 2 PRODUCTS

2.01 TOPSOIL

- A. Topsoil shall consist of any soil suitable for the growth of grass or other cover crops reasonably free from hard dirt, clay, rocks, or other materials which would inhibit the germination of seeds or the growth of the cover crop. Classification of soils suitable for topsoil will be at the discretion of Engineer.

PART 3 EXECUTION

3.01 STRIPPING AND STORING TOPSOIL

- A. Prior to stripping topsoil from the designated areas, brush, grass, agricultural crops, or other suitable material shall be conserved as mulch and incorporated into the topsoil. The material shall be chopped through a brush chopper, shredded by means of a commercial-sized rotary blade mower, or reduced by other approved methods.
- B. Unless it can be placed directly on the prepared slopes, topsoil shall be stockpiled for later incorporation into the work. Stockpiles shall be placed at the location and to the dimensions designated by Engineer.

3.02 PREPARATION OFF AREAS

- A. The embankment or cut slope areas to be covered with topsoil shall be completed to the designated lines and grades. Areas that have become crusted or hard-packed shall be scarified to a depth of approximately 3 inches, prior to placement of the topsoil.

3.03 PLACING TOPSOIL

- A. Topsoil shall be placed in a uniform manner to a depth commensurate with the quantity of topsoil available and the area to be covered.
- B. After the topsoil has been spread, large stiff clods, stones, or other foreign material that would seriously affect the effectiveness or appearance of the topsoil, shall be raked up and removed from the area. Topsoil shall be keyed to the underlying material by scarifying.
- C. Water shall be applied to the topsoil at the locations and in the amounts designated. Water shall be applied in a fine spray by nozzles or spray bars in such a manner that it will not wash or erode the topsoil areas.

PART 4 METHOD OF MEASUREMENT AND BASIS OF PAYMENT

4.01 METHOD OF MEASUREMENT

- A. When topsoil is taken from stockpiles, the measurement will be made as the difference, in cubic yards, between the quantity in the stockpile and the remaining after the topsoil required under the contract has been removed.
- B. Topsoil borrow will be measured by the cubic yard. The volume will be determined by preliminary and final cross-sections of the borrow area or by other approved methods of determining actual volumes removed from the borrow area and agreed to prior to the work by Engineer and Contractor.
- C. The item "Topsoil Borrow" will include all work required for stripping the material from its original position and placing the material in its final position.

4.02 BASIS OF PAYMENT

- A. The accepted quantities of topsoil will be paid for at the contract price per cubic yard, complete in place. Payment will be made under:

PAY ITEM	PAY UNIT
Topsoil	Cubic Yards
Topsoil Borrow	Cubic Yards

END OF SECTION

SECTION 02290 — WATERING

PART 1 GENERAL

1.01 SUMMARY

- A. This item shall consist of furnishing and applying water required in the compaction of embankments, sub-grades, base courses, and surface course, or for the control of dust for the safety and convenience of the public, for the reduction of the dust nuisance with adjacent property, or for other purpose as directed by Engineer, in accordance with the requirements of these specifications.

PART 2 MATERIALS

2.01 WATER SOURCE

- A. Water required for compaction, dust control or other purposes shall be the responsibility of Contractor to obtain. Water quality shall meet or exceed that required by Federal, State, or local government agencies of authority.

PART 3 EXECUTION

3.01 WATER ADDED

- A. Deficiencies in moisture content of embankment materials, aggregate sub-base, base, or surfacing courses shall be corrected by the addition of water by approved water distribution equipment. Water for dust control, finishing operations, and seeding shall be applied by approved distributor equipment.
1. Grading Operations. Pre-wetting does not guarantee that additional water will not be required. Water added to embankment material during grading operations shall be distributed in a manner that will avoid ponding or over-wetting materials for the full width of each layer of material placed.
 2. Aggregate Courses. Water added to aggregate courses shall be applied to the material immediately prior to mixing and placing the material.
 3. Finishing Operations. Water added during finishing operations shall be uniformly applied in a fine spray across the full width of the course by means of controllable pressures and spray bars or nozzles.
 4. Seeding. Water added to seeded areas shall be applied in a spray that will not wash or erode the seeded area.
 5. Dust Control. Water ordered for dust control measures for the protection and safety of traffic, for abatement of air pollution, or for other purposes, shall be applied in a manner that will best accomplish the elimination of dust.

PART 4 METHOD OF MEASUREMENT AND BASIS OF PAYMENT

4.01 METHOD OF MEASUREMENT

- A. No method of measurement is required except that agreed upon by Contractor and the entity from which he receives water.

4.02 BASIS OF PAYMENT

- A. This item shall be considered subsidiary to other work with no additional pay necessary.

END OF SECTION

SECTION 02510 — PORTLAND CEMENT TREATED MIXTURES

PART 1 GENERAL

1.01 SUMMARY

A. Provide portland cement treated mixtures over prepared sub-base as follows:

1. Cement treated base.

1.02 RELATED WORK

- A. Section 02190 Aggregates
- B. Section 02231 Aggregate Sub-Base and Base Courses
- C. Section 03304 Portland Cement Concrete
- D. Section 02210 Excavation and Embankment
- E. Section 02225 Trench Backfill

1.03 SUBMITTALS

- A. Submit for approval product data, test reports and mix design.

1.04 QUALITY ASSURANCE

- A. Comply with governing codes and regulations. Provide products of acceptable manufacturers which have been in satisfactory use in similar service for three years. Use experienced installers. Deliver, handle, and store materials in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Cement and water: Comply with Section 03304, PORTLAND CEMENT CONCRETE.
- B. Aggregate:
 - 1. Cement treated base: Comply with pavement base coarse specification under Section 02231, AGGREGATE SUB-BASE AND BASE COARSE.
- C. Admixtures (when required): Comply with pozzolan admixture, or fly ash specification, under Section 03304, PORTLAND CEMENT CONCRETE, and with ASTM C 311 and C 618, Class C or F.
- D. Bituminous curing/sealing compound: Comply with liquid or emulsified asphalt specification under Section 02545, BITUMINOUS MATERIALS.

PART 3 EXECUTION

3.01 PROPORTIONING OF MATERIALS

A. Cement treated base:

1. Comply with applicable measurement, proportioning, and mixing specifications under Section 03304, PORTLAND CEMENT CONCRETE.
2. Mixing can be performed as follows, at Contractor's option:
 - a. Roadbed: Uniform windrows of untreated base shall be shaped and the tops slightly flattened to receive the cement. The size of the windrows shall be limited such that all the material can pass through the mixing machine in one operation. Cement shall be spread uniformly on the base material, and completely mixed. Water shall be applied under pressure with controlled distributing equipment, and mixing shall continue until the base is a homogeneous mixture with uniform moisture content.
 - b. Central plant: Cement, water, aggregate and admixture(s) if required, shall be stored separately. Plants shall use an approved pug mill or continuous flow mixer, to produce a homogeneous mixture of uniformly distributed and properly coated aggregates with consistent appearance. The total elapsed time between the addition of water to the mixture and the start of compaction shall not exceed 45 minutes. The mixture shall be transported to the site in clean equipment with suitable protective devices to prevent material loss and significant moisture change.

3.02 INSTALLATION

- A. Comply with applicable subgrade preparation and compaction specifications under Sections 02210, EXCAVATION AND EMBANKMENT and 02225, TRENCH BACKFILL. Subgrade shall conform to the lines, grades, and cross sections shown on the Plans.
- B. Cement treated base: Spread mixture with a jersey spreader and motor grader over properly prepared subgrade. Uniformly compact the treated base with pneumatic rollers to at least 100 percent of maximum density determined in accordance with AASHTO T 99. The maximum compacted thickness of any one layer shall not exceed 6 inches. The surface of the base course shall be lightly scarified, re-graded, reshaped, and re-compacted to the lines, grades, and cross sections shown on the Plans.

3.03 CURING AND PROTECTION

- A. Moist curing (water fogging): Exposed surfaces of controlled density backfill and cement treated base shall be kept continuously moist with a fog spray for 7 days.
- B. Bituminous seal: Immediately after final rolling, bituminous curing of either liquid or emulsified asphalt shall be applied in sufficient quantity to provide a continuous

membrane over the treated mixture, at a rate of between 0.1 and 0.2 gallons per square yard of surface area.

- C. Remove and replace entire depth of defective work.

PART 4 METHOD OF MEASUREMENT AND BASIS OF PAYMENT

4.01 METHOD OF MEASUREMENT

- A. Unless otherwise noted in the special provisions, no separate measurement will be made for items under this section. Full compensation shall be considered as included in the prices paid for the various contract items and no additional compensation will be allowed.

4.02 BASIS OF PAYMENT

- A. Unless otherwise noted in the special provisions, no separate payment will be made for items under this section. Full compensation shall be considered as included in the prices paid for the various contract items and no additional compensation will be allowed.

END OF SECTION

SECTION 02511 — ROAD MIX AND BITUMINOUS PAVEMENTS

PART 1 GENERAL

1.01 SUMMARY

- A. These specifications include general requirements that are applicable to all types of road mix bituminous pavements irrespective of the gradation of aggregate, kind, and the amount of bituminous material or pavement used.
- B. This work shall consist of constructing one or more courses of a road mix bituminous mixture on the prepared foundation in accordance with these specifications, and in reasonably close conformity with the lines, grades, thickness, and typical cross sections on the plans or established by Engineer.

1.02 RELATED WORK

- A. Section 02190, Aggregates
- B. Section 02512, Plant Mix Pavements
- C. Section 02545, Bituminous Materials
- D. Section 02550, Prime Coat
- E. Section 02551, Tack Coat

1.03 REFERENCES

- A. AASHTO T40: Sampling Bituminous Materials
- B. AASHTO T2: Sampling Aggregates
- C. AASHTO T27: Wyoming Modified Sieve Analysis
- D. ASTM C136: Sieve Analysis

PART 2 PRODUCTS

2.01 MATERIALS

- A. The type and grade of bituminous material will be specified in the Contract Documents. The grade may be changed one step by Engineer during construction at no change in unit price. The bituminous material shall meet the applicable requirements of Section 02545, BITUMINOUS MATERIALS.
- B. The aggregate will be accepted immediately preceding addition of bituminous material to the mix. The aggregates shall meet the requirements of Section 02190, AGGREGATES. This acceptance will be based on periodic samples of the windrow after all aggregates have been blended for each lift.

- C. Stockpiled material shall meet the requirements of Section 02190, Subsection 3.01, STOCKPILED AGGREGATE.

PART 3 EXECUTION

3.01 PREPARATION

- A. Before materials for road mixing are spread, the surface on which the road mix is to be placed shall be conditioned as specified in Section 02512, PLANT MIX PAVEMENTS, Subsection 3.01, and primed and tacked, where required, in accordance with Section 02550, PRIME COAT, and Section 02551, TACK COAT, respectively.
- B. The construction of road mix bituminous pavement shall be carried on only when the surface on which the material is to be placed is dry and when the atmospheric temperature is above 50°F and has not been below 40°F during the preceding 24 hours.
- C. The equipment used by Contractor shall include scarifying, mixing, spreading, finishing, and compacting equipment, a bituminous distributor, and equipment for heating bituminous material.
- D. The distributor shall be so designed, equipped, maintained, and operated that bituminous material at even heat may be applied uniformly on variable widths of surface up to 15 feet at readily determined and controlled rates, from 0.05 to 2.0 gallons per square yard, with uniform pressure and with an allowable variation from any specified rate not to exceed 0.02 gallon per square yard. Distributor equipment shall include a tachometer, pressure gauges, accurate volume measuring devices or a calibrated tank, and thermometer for measuring temperatures of tank contents. Distributors shall be equipped with a power unit for the pump and full circulation spray bars adjustable laterally and vertically.
- E. Traveling or stationary mixing plants or other equipment of proven performance may be used by Contractor in lieu of the specified equipment if approved.
- F. Rollers shall be of self-propelled steel wheel tandem or 3-wheel rollers weighing not less than 8 tons each. Pneumatic-tired rollers shall have a total compact width of not less than 60 inches and a gross weight adjustable within the range of 200 to 350 pounds per square inch of compaction width. The operating weight shall be as directed. Tire pressure or contact pressure may be specified for pneumatic-tired rollers.

3.02 INSTALLATION

- A. PLACING AGGREGATES
 - 1. Aggregates shall be uniformly spread on the road by the use of spreader boxes or other approved mechanical spreading devices. When two or more sizes of aggregates are used, each size of aggregate shall be placed in the proper amount to provide for surfacing of the required width and thickness. Each size of

aggregate shall be windrowed to uniform section and left undisturbed until measuring and sampling are completed, after which they shall be mixed until they are uniformly blended and then spread over the road surface.

2. If the surface moisture of the aggregate is more than 2 percent of the dry weight of the aggregate, except when the bituminous material is emulsified asphalt, the aggregate shall be turned by blades or disc harrows or otherwise aerated until the moisture content is reduced to 2 percent or less. The aggregate shall then be spread smoothly and uniformly over half the road or other convenient width of the surface ready for the application of bituminous material, except that when a traveling mixing plant is used, the aggregate shall be formed into a uniform cross section.
3. In lieu of aerating and drying the aggregate, Contractor may use an approved additive. The additive shall permit suitable coating of the wet aggregate and shall prevent the bituminous coating from stripping in the presence of water.

B. APPLICATION OF BITUMINOUS MATERIAL

1. The bituminous material shall be uniformly distributed in successive applications, in such amounts and at such intervals as directed. The mixing equipment shall follow immediately behind the distributor after each application of bituminous material to partially mix the aggregate and the bituminous material. Application temperature shall be in accordance with Section 02545, BITUMINOUS MATERIALS, Subsection 3.02.

C. MIXING

1. After the last application of bituminous material and partial mixing, the entire mass of bituminous material and aggregate shall be windrowed on the road surface and then mixed, by blading the mixture from side to side of the road or by manipulations producing equivalent results, until all aggregate particles are coated with bituminous material and the whole mass has a uniform color, and the mixture is free from rich or lean spots, balls, or uncoated particles. During the mixing operations, care shall be taken to avoid cutting into the underlying coarse or contaminating the mixture with the earth or other extraneous matter. The mixing process shall be confined to part of the width or area of the road when required to allow traffic to pass.
2. Should the mixture show an excess, deficiency, or uneven distribution of bituminous material, the condition shall be corrected by the addition of aggregate or bituminous material as required, and remixing. If the mixture contains excessive amounts of moisture or volatile matter, it shall be bladed, aerated, or otherwise manipulated until the moisture and volatile contents are satisfactory. The spreading of the mix shall not be done when the surface to be covered is in an unsatisfactory condition.

3. At the end of the day's work, or when the work is interrupted by weather conditions or otherwise, all loose material shall be bladed into a windrow whether or not mixing is completed, and shall be retained in a windrow until operations are resumed.
4. When the mixing operations have been satisfactorily completed, the mixture shall be formed into a windrow of uniform cross section.
5. If Contractor requests, and is authorized to use, traveling or stationary mixing plants in lieu of the specified equipment, the same requirements regarding residual moisture and evaporation of volatiles given above shall apply.

D. SPREADING, COMPACTING AND FINISHING

1. The material shall be spread by a self-propelled, pneumatic-tired blade grader or a mechanical spreader of approved type. Care shall be taken to avoid cutting into the underlying base when the material is spread from the windrow.
2. After the material is spread, the surface shall be rolled. Rolling shall be parallel to the road centerline and shall commence at the outer edges of the road, overlapping the shoulders, and progress toward the center, overlapping on successive passes by at least one-half the width of the roller, except that on super-elevated curves rolling shall progress from the lower to the upper edge. Each pass shall terminate at least 3 feet in advance or to the rear of the end of the preceding pass. During the compaction, the surface shall be dragged or bladed as necessary to fill ruts and to remove incipient corrugations or other irregularities. Rolling shall continue until the surfacing is of uniform texture and satisfactory compaction has been obtained. Initial rolling shall be performed with a pneumatic-tired roller, and final rolling shall be performed with a 3-wheel or tandem-type steel wheel roller. Rolling shall be discontinued whenever it begins to produce excessive pulverizing of the aggregate or displacement of the mixture.
3. Where the compacted thickness of the road mix surface is to be more than 2 inches, the mixture shall be spread from the windrow and compacted in two layers, the first layer to be bladed and rolled before the second layer is spread.
4. While the surface is being compacted and finished, Contractor shall trim the edges neatly to line.

3.03

SURFACE REQUIREMENTS

- A. The surface will be tested by Engineer using a 10-foot straightedge at selected locations. The variation of the surface shall at no point exceed 1/4 inch. All humps or depressions exceeding the specified tolerance shall be corrected by removing defective work and replacing it with new material as specified.

PART 4 METHOD OF MEASUREMENT AND BASIS OF PAYMENT

4.01 METHOD OF MEASUREMENT

- A. Aggregate and bituminous material will be measured by the ton. The weight of the natural moisture in the aggregate will not be deducted from the pay quantities.

4.02 BASIS OF PAYMENT

- A. The accepted quantities of road mix bituminous pavement will be paid for at the contract unit price per ton for aggregates and bituminous material complete in place. Payment will be made under:

PAY ITEM	PAY UNIT
Aggregate for Road Mix Bit. Pavement	Ton
Liquid Asphalt (RM Bit. Pavement.)	Ton or Gal.
Emulsified Asphalt (RM Bit. Pavement.)	Ton or Gal.

END OF SECTION

SECTION 02512 — PLANT MIX PAVEMENTS

PART 1 GENERAL

1.01 SUMMARY

- A. These specifications include general requirements that are applicable to all types of bituminous pavements of the plant mix type irrespective of gradation of aggregate, kind, and amount of bituminous material or pavement use. Deviations from these general requirements will be indicated in the specific requirements for each type.
- B. This work shall consist of one or more courses of bituminous mixture constructed on the prepared foundation in accordance with these specifications and the specific requirements of the type under contract, and in reasonably close conformity with the lines, grades, thickness and typical cross sections shown on the plans or established by Engineer.

1.02 RELATED WORK

- A. Section 02190, Aggregates
- B. Section 02545, Bituminous Materials
- C. Section 02550, Prime Coat
- D. Section 02551, Tack Coat
- E. Section 02552, Seal Coat

1.03 REFERENCES

- A. ASTM C150: Portland Cement
- B. AASHTO M303: Lime for Asphalt Mixtures
- C. AASHTO T166: Standard Method of Test for Bulk Specific Gravity (Gmb) of Compacted Hot Mix Asphalt (HMA) Using Saturated Surface-Dry Specimens
- D. AASHTO T209: Standard Method of Test for Theoretical Maximum Specific Gravity (Gmm) and Density of Asphalt Mixtures
- E. AASHTO T245: Standard Method of Test for Resistance to Plastic Flow of Asphalt Mixtures Using Marshall Apparatus
- F. AASHTO T275: Standard Method of Test for Bulk Specific Gravity (Gmb) of Compacted Asphalt Mixtures Using Paraffin-Coated Specimens
- G. AASHTO M323: Standard Specifications for Superpave Volumetric Mix Design
- H. AASHTO R35: Standard Practice for Superpave Volumetric Design for Asphalt Mixtures

- I. WYDOT 215.0: In-Place Density and Moisture Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)
- J. WYDOT 418.0: Recommended Procedure for Nuclear Density Gauge Correlation (Bituminous Pavements)

1.04 SUBMITTALS

- A. Contractor shall submit for Engineer's approval a job-mix formula for each mixture to be supplied for the project. The job-mix formula combined grading shall be within the master range specified before the application of the allowable tolerances. The job-mix formula for each mixture shall establish a single percentage of aggregate passing each required sieve size and a single mixing temperature. Should a change in sources of material be made, a new job-mix formula shall be established before the new material is used. When unsatisfactory results or other conditions make it necessary, Engineer may require the submittal of a new job-mix formula, for which no additional compensation will be provided.
- B. Mixing plant scales shall be checked as often as deemed necessary to assure their continued accuracy. Contractor shall have on hand not less than ten 50-pound weights for checking of the scales.

1.05 DEFINITIONS

- A. Plant mix pavement is considered a surface course in all cases.
- B. Plant mix bituminous base is considered a sub-surface course.

PART 2 PRODUCTS

2.01 MATERIALS

- A. BITUMINOUS MATERIALS
 - 1. Unless otherwise specified, PG 64-22 shall be used for overlays, and PG 64-28 shall be used for new construction of bituminous pavements on prepared foundation.
 - 2. The bituminous material shall meet the applicable requirements of Section 02545, BITUMINOUS MATERIALS
- B. AGGREGATE MATERIALS
 - 1. Aggregates shall meet the applicable requirements of Section 02190, AGGREGATES.
 - 2. During crushing operations, the course and fine aggregates shall be stockpiled in separate piles in such manner that they can later be combined to meet the required specifications.

3. Stockpiled material shall meet the requirements of Section 02190, AGGREGATES, Subsection 3.01.
4. Natural filler, when required, shall be stockpiled separately. The plans may limit or prohibit the use of crusher rejects or material from the same source as the aggregate material.

C. COMMERCIAL ADDITIVES

1. The type of commercial additive to be used will either be designated on the plans, or when no specific type is designated, any of the Commercial Additives conforming to either of the following requirements may be used:
 - a. PORTLAND CEMENT - Portland Cement shall conform to the requirements of ASTM C 150.
 - 1) Unless otherwise permitted by Engineer, the product of only one mill of any one brand and type of portland cement shall be used on the project.
 - 2) Contractor shall provide suitable means for storing and protecting the cement against dampness. Cement which, for any reason, has become partially set or which contains lumps of caked cement shall be rejected. Cement salvaged from discarded or used bags shall not be used.
 - b. HYDRATED LIME - Hydrated lime shall conform to the requirements of AASHTO M 303, except that not less than 93 percent of the hydrated lime shall consist of calcium and magnesium oxides.

D. COMPOSITION OF MIXTURES

1. The bituminous plant mix shall be composed of a mixture of aggregate, natural filler or commercial additive, if required, and bituminous material. The several aggregate fractions shall be sized, uniformly graded, and combined in such proportions that the resultant composite blend meets the job-mix formula.
2. After the job-mix formula is established, all mixtures furnished for the project shall conform thereto within the following ranges of tolerances:

Passing #4 and Larger Sieves	-7 to +7 percent
Passing #8 to #100 Sieves	-5 to +5 percent
Passing #200 Sieve	-3 to +3 percent
Bituminous Material	-0.5 to +0.5 percent
Mixing Temperature	-20 to +20 degrees F

3. In general, the point of acceptance for the aggregate will be after the material has passed through the gradation unit and prior to the addition of bituminous material. If this point of acceptance proves unsatisfactory, an alternate point of acceptance may be selected by Engineer. The bituminous material will be conditionally accepted at the source. The plant-mixed material will be accepted after blending and mixing at the plant.

4. At the option of Contractor, the proposed job-mix formula shall conform to either the Marshall or Superpave requirements shown in the following table. Unless otherwise specified, the number of Marshall blows shall be 50 or the number of Superpave gyrations shall be 50. If Contractor proposes the use of a job-mix formula in excess of one year old at the commencement of production, Contractor shall provide such additional test results to demonstrate the proposed job-mix formula represents the materials proposed for use.

Property	Class			
	II-M	III-M	II-S	III-S
Number of Marshall blows	75	50		
Marshall stability, lbs minimum	2500	2000		
Marshall flow (0.01 in)	8-16	8-16		
Number of Superpave gyrations			75	50
% voids in laboratory mix	4.0	4.0	4.0	4.0
% voids in production mix	3.0-5.0	2.5-5.0	3.0-5.0	2.5-5.0
Dust/effective asphalt binder	0.8-1.4	0.8-1.4	0.8-1.4	0.8-1.4
Minimum % asphalt binder	4.5	4.5	4.5	4.5
Minimum tensile strength retained (%)	75	75	75	75
Voids filled with asphalt binder (VFA, %)			65-78	65-78

5. The proposed job-mix formula shall conform to the Percent Voids in Mineral Aggregate (VMA) requirements shown in the table below:

Class	Nominal Maximum Aggregate Size (NMAS)		
	¾ inch [19 mm]	½ inch [12.5 mm]	3/8 inch [9.5 mm]
Laboratory Mix			
II-M, II-S	13.0 - 16.0	14.0 - 17.0	14.0 - 17.0
III-M, III-S	12.0 - 15.0	13.0 - 16.0	13.0 - 16.0
Production Mix			
II-M, II-S	12.0 - 16.0	13.0 - 17.0	13.0 - 17.0
III-M, III-S	11.0 - 15.0	12.0 - 16.0	12.0 - 16.0

PART 3 EXECUTION

3.01 PREPARATION

A. CONDITIONING OF EXISTING SURFACE

- Irregular surfaces of existing pavements or bases shall be brought to uniform grade and cross section as directed.
- When specified in the Contract Documents, all longitudinal and transverse joints and all cracks shall be sealed by the application of an approved joint sealing compound before the mixture is spread upon a pavement surface. All excessive bituminous material shall be removed from joints and cracks prior to placement of the mixture.

B. PREPARATION OF BITUMINOUS MATERIAL

1. The bituminous material shall be handled and stored in accordance with the manufacturer's recommendations in a manner that will avoid local overheating and provide a continuous supply of the bituminous material to the mixer at a uniform temperature at all times.

C. PREPARATION OF AGGREGATE

1. The aggregates for the mixture shall be dried and heated to the required temperature. Flames used for drying and heating shall be properly adjusted to avoid damage to the aggregate or coating the aggregate with soot, oil, or other contaminants.

D. MIXING

1. The dried aggregate shall be combined in the amount of each fraction of aggregates required to meet the job-mix formula. The bituminous material shall be measured or gauged and introduced into the mixer in the amount specified by the job-mix formula.
2. After the required amounts of aggregate and bituminous material have been introduced into the mixer, unless otherwise specified, the materials shall be mixed until a complete and uniform coating of the particles and a thorough distribution of the bituminous material throughout the aggregate is secured.
3. For hot mix bituminous pavement, the mixture shall be produced within the temperature range recommended by the manufacturer of the bituminous material.

E. BITUMINOUS MIXING PLANT - GENERAL

1. The different aggregate sizes shall be kept separated until they have been delivered to the bituminous mixing plant.
2. Plants used for preparation of bituminous mixtures shall conform to all requirements under Subsection 3.01(F) below, except that scale requirements shall apply only where weight proportioning is used. In addition, batch mixing plants shall conform to the requirements under Subsection 3.01(G) herein, continuous mixing plants shall conform to the requirements under Subsection 3.01(H) herein, and dryer-drum mixers shall conform to the requirements under Subsection 3.01(I) herein.
3. Mixing plants shall be of sufficient capacity and coordinated to adequately handle the proposed bituminous construction.

F. REQUIREMENTS FOR ALL PLANTS

1. Plant Scales - Scales shall be accurate to 0.5 percent of the maximum load that may be required. Poles shall be designed to be secured in any position to prevent

inadvertent change of position. Contractor may provide an approved automatic printer system which will print the weights of the material delivered, provided the system is used in conjunction with an approved automatic batching and mixing control system. Such weights shall be evidenced by a weigh ticket for each load.

2. Equipment for Preparation of Bituminous Material - Tanks for the storage of bituminous material shall be equipped to heat and hold the material at the required temperatures. The heating shall be accomplished by steam coils, electricity, or other approved means so that no flame shall be in contact with the tank. The circulating system for the bituminous material shall be designed to assure proper and continuous circulation during the operating period. Provision shall be made for measuring and sampling storage tanks.
3. Feeder for Drier - The plant shall be provided with accurate mechanical means for uniformly feeding the aggregate into the drier so that uniform production and uniform temperature will be obtained.
4. Drier - The plant shall include a drier or driers which continuously agitate the aggregate during the heating and drying process. For cold-type bituminous mix, equipment for mechanical cooling of the dried aggregate to the temperature prescribed for cold mixtures shall be provided and shall be capable of supplying prepared material for the mixer to operate at full capacity.
5. Bins - The plant shall include storage bins of sufficient capacity to supply the mixer when it is operating at full capacity. Bins shall be arranged to assure separate and adequate storage of appropriate fractions of the mineral aggregates. Separate dry storage shall be provided for commercial additives when used, and the plant shall be equipped to feed such material into the mixer.
6. Sampling Facilities - The plant shall be equipped with suitable sampling devices or facilities to insure representative samples. If Engineer is unable to obtain samples which represent the material being accepted for incorporation into the project, Contractor shall make necessary adjustments or revisions to the plant before any further mixing is done.
7. Bituminous Control Unit - Satisfactory means, either by weighing or metering, shall be provided to obtain the proper amount of bituminous material in the mix. The accuracy of bituminous content measured either by weighing or metering may be checked by computing the daily yield of total material being processed.
8. Thermometric Equipment
 - a. An armored thermometer of adequate range in temperature reading shall be fixed in the bituminous feed line at a suitable location near the charging valve at the mixer unit.
 - b. The plant shall also be equipped with an approved temperature recording device so placed at the discharge chute of the drier as to register

automatically or indicate the temperature of the heated aggregates. The printed temperature recordings shall be furnished to Engineer after each day's run.

9. Dust Collector - The plant shall be equipped with a dust collector constructed to waste or return uniformly to the mixing chamber all or any part of the material collected as directed.
10. Truck Scales - The bituminous mixture shall be weighed on approved scales. Such scales shall be inspected as often as Engineer deems necessary to assure their accuracy.

G. REQUIREMENTS FOR BATCHING PLANTS

1. Weigh Box or Hopper - The equipment shall include a means for accurately weighing each size of aggregate in a weigh box or hopper suspended on scales and of ample size to hold a full batch without running over. The gate shall close tightly so that no material is allowed to leak into the mixer while a batch is being weighed.
2. Bituminous Control
 - a. The equipment used to measure the bituminous material shall be accurate to plus or minus 0.5 percent.
 - b. The bituminous material bucket shall be non-tilting type with a loose sheet metal cover. The capacity of the bituminous material bucket shall be at least 15 percent in excess of the weight of bituminous material required in any batch. The length of the discharge opening or spray bar shall be not less than three-quarters of the length of the mixer, and it shall discharge directly into the mixer. The size and spacing of the spray bar openings shall provide a uniform application of bituminous material the full length of the mixer.
 - c. The bituminous material bucket, its discharge valve or valves, and spray bar shall be adequately heated. Steam jackets, if used, shall be efficiently drained, and all connections shall be so constructed that they will not interfere with the efficient operation of the bituminous scales. The plant shall have an adequately heated quick-acting, non-drip, charging valve located directly over the bituminous material bucket.
 - d. The indicator dial shall have a capacity of at least 15 percent in excess of the quantity of bituminous material used in a batch. The controls shall be constructed so that they may be secured at any dial setting and will automatically reset to that reading after the addition of bituminous material to each batch. The dial shall be in full view of the mixer operator. The flow of bituminous material shall be automatically controlled so that it will begin when the dry mixing period is over and all of the bituminous material required

for one batch will be discharged in not more than 15 seconds after the flow has started.

3. Mixer

- a. The batch mixer shall be an approved twin pug mill type capable of producing a uniform mixture within the job-mix tolerances. If not enclosed, the mixer box shall be equipped with a dust hood to prevent loss of dust.
- b. The clearance of blades from all fixed and moving parts shall not exceed 1 inch.
- c. The mixer shall be equipped with an accurate time lock to control the operations of a complete mixing cycle. It shall lock the weigh box gate after the charging of the mixer until the closing of the mixer gate at the completion of the cycle. It shall lock the bituminous material bucket throughout the dry mixing period and shall lock the mixer gate throughout the dry and wet mixing periods. The dry mixing period is defined as the interval of time between the opening of the weigh box gate and the start of introduction of bituminous material. The wet mixing period is the interval of time between the start of introduction of bituminous material and the opening of the mixing gate.
- d. The control of the timing shall be flexible and capable of being set at intervals of 5 seconds or less throughout a total cycle of up to 3 minutes.
- e. The setting of time intervals shall be performed in the presence of Engineer, who shall then lock the case covering the timing device until such time as a change is to be made in the timing periods.

H. REQUIREMENTS FOR CONTINUOUS MIXING PLANTS

1. Aggregate Proportioning

- a. The plant shall include means for accurately proportioning each size of aggregate.
- b. The plant shall have a feeder mounted under each compartment bin. Each compartment bin shall have an accurately controlled, individual gate to form an orifice for volumetrically measuring the material drawn from each compartment. The feeding orifice shall be rectangular with one dimension adjustable by positive mechanical means and secured against inadvertent movement.
- c. Indicators shall be provided for each gate to show the respective opening in inches.

2. Weight Calibration of Aggregate Feed - The plant shall include a means for calibration of gate openings by weighing test samples. Provision shall be made so that materials fed out of individual orifices may be bypassed to individual test boxes. The plant shall be equipped to conveniently handle individual test samples

weighing not less than 200 pounds, and accurate scales shall be provided by Contractor to weigh such test samples.

3. Synchronization of Aggregate Feed and Bituminous Material Feed - Satisfactory means shall be provided to afford positive interlocking control between the flow of aggregate from the bins and the flow of bituminous material from the meter or other proportioning device. This control shall be accomplished by interlocking mechanical means or by any other positive, satisfactory method.

4. Mixer

- a. The plant shall include a continuous mixer capable of producing a uniform mixture within the job-mix tolerances.

- I. REQUIREMENTS FOR DRYER-DRUM MIXER

1. The plant shall be equipped to control aggregate gradation as described for cold feed control. The total cold aggregate feed shall be weighed continuously by an approved belt scale. When tested for accuracy, the weighing system shall register within plus and minus 0.5 percent. Provisions shall be made for determining the moisture content of the cold feed and correcting the aggregate weight to a dry weight.
2. An automatic digital record of the dry aggregate and the asphalt shall be displayed, recorded and totaled in appropriate units of weight and time. A positive interlock shall be provided between the dry weight of the aggregate and the bituminous material. The flow of the bituminous material shall be adjusted to compensate for the changes in the dry weight of the aggregate.
3. The dryer-drum mixer shall be capable of drying and heating the aggregate to the moisture and temperature requirements. A uniform mixture of aggregates and bituminous material shall be produced. The plant shall have a temperature recording device at the discharge chute of the dryer.

3.02

APPLICATION

- A. The temperature of the mixture prior to laydown shall not be more than 25°F less than the mixing temperature.
- B. Bituminous plant mix shall not be placed on any wet or frozen surface or when weather conditions prevent the proper handling, finishing, and compaction of the bituminous mixture.

- C. HAULING EQUIPMENT

1. Trucks used for hauling bituminous mixtures shall have tight, clean, smooth, metal beds which have been thinly coated with a minimum amount of paraffin oil or other approved material to prevent the mixture from adhering to the beds. This material shall not be used in amounts which will contaminate the mixture. When required, each truck shall have a cover of canvas or other suitable material of such

size as to protect the mixture from the weather. When necessary, so that the mixture will be delivered on the road at the specified temperature, truck beds shall be insulated and covers shall be securely fastened.

2. Railroad cars used for transportation of cold-laid bituminous mixtures shall be in good condition and without pockets. All projecting spikes, nails, foreign material, and other obstructions likely to interfere with efficient unloading shall be removed from the cars. The bottoms of the cars shall be covered with a thin layer of clean sand or screenings, and the top of the load shall be protected from contamination by moisture or foreign materials, and from the loss of volatile material.

D. SPREADING AND FINISHING

1. The mixture shall be laid upon an approved surface, spread, and struck off to the grade and elevation established. Bituminous pavers shall be used to distribute the mixture either over the entire width or over such partial width as may be practicable.
2. When the total compacted thickness of the mat is to be in excess of 2 inches, it shall be placed in two or more lifts. The compacted thickness of any one lift in multiple-lift construction shall not exceed 2 inches.
3. Except on tapers, narrow median areas, shoulders, and other such areas of irregular shape, limited length or restrictive width, or such other areas as directed, the paver screed shall be controlled by the automatic screed control described under Subsection 3.02(G) herein.
4. Engineer will perform such engineering as may be required to establish controls for the work and will set references for line and grade controls at reasonable intervals along the work.
5. Contractor shall furnish, place, and maintain such materials, devices, and equipment as may be required to provide specified independent line and grade control references and other controls which may be required for proper execution of the work.
6. Line and grade control for use with automatic paver control systems shall be an independent control reference consisting of:
 - a. A tightly stretched wire or string line offset and paralleling true line for pavement edge and established grade for pavement surface; or
 - b. A floating beam of not less than 20 feet in length attached to the paver and riding on previously placed base or pavement material. The beam shall be equipped with a floating string or other device that will actuate the automatic screed control in reference to the base on which it is riding.

7. The longitudinal joint in one layer shall offset that in the layer immediately below, by at least 6 inches. Reasonable effort in positioning longitudinal joints such that joints do not fall in wheel paths is required. Longitudinal joint locations may be otherwise specified in the Contract Documents.
8. Defects caused by trucks bumping into the laydown machine or by unnecessary stopping due to lack of coordination between mixing, hauling, and laydown shall be removed and replaced in accordance with Subsection 3.04.
9. On areas where irregularities or unavoidable obstacles make the use of mechanical spreading and finishing equipment impracticable, the mixture shall be spread, raked and luted by hand tools. For such areas the mixture shall be dumped, spread, and screeded to give the required compacted thickness and density.
10. Unless otherwise approved by Engineer, Plant mix surfacing ribbons shall be brought up approximately even at the end of each shift on those projects being constructed under traffic.

E. BITUMINOUS PAVERS

1. Bituminous pavers shall be self-contained, power-propelled units, provided with an activated screed or strike-off assembly, heated if necessary, and capable of spreading and finishing courses of bituminous plant mix material in lane widths applicable to the specified typical section and thickness shown on the plans. Pavers used for shoulders and similar construction shall be capable of spreading and finishing courses of bituminous plant mix material in widths shown on the plans.
2. The paver shall be equipped with a receiving hopper having sufficient capacity for a uniform spreading operation. The hopper shall be equipped with a distribution system to place the mixture uniformly in front of the screed.
3. The screed or strike-off assembly shall effectively produce a finished surface of the required evenness and texture without tearing, shoving, or gouging the mixture.
4. Pavers shall be equipped with a paver control system which will automatically control the laying of the mixture to be specified transverse slope and established longitudinal grade. The paver control system shall be automatically actuated from one or more grade averaging devices (skis) and/or an independent line and grade control reference and through a system of mechanical or electronic sensors and sensor-directed devices which shall maintain the paver screed at the proper transverse slope and at proper height to establish the top surface of the finally compacted mixture at specified slope and grade. In case of failure of the control system, the paver shall be operated by mechanical control only until the material under production at the time of breakdown is laid.

5. The paver shall be capable of being operated, when laying mixtures, at forward speeds consistent with satisfactory laying of the mixture.
6. A paving leveler shall be used when specified as shall be described in the Special Provisions.

F. ROLLERS

1. All rollers shall be in good condition, capable of reversing without backlash, and shall be operated at speeds slow enough to avoid displacement of the bituminous mixture. The number and weight of rollers shall be sufficient to compact the mixture to the required density while it is still in a workable condition. The use of equipment which results in excessive crushing of the aggregate will not be permitted.
2. The pneumatic-tired roller shall be self-propelled with a total weight, including ballast, no greater than 30 tons. The roller shall be constructed so contact pressure may be varied between 40 psi and 90 psi. Unless otherwise approved by Engineer, the use of a pneumatic-tired roller is required.
3. Wobble wheel rollers are not permitted. Each roller shall be equipped with not less than 7 wheels with tires of equal size and ply and having a smooth tread design. The wheels shall be staggered on the front and rear axles to provide complete coverage, have a system for uniformly moistening each wheel without an excess of water, and have close-fitting scrapers for each wheel. The tire pressures shall not vary by more than 5 psi between individual tires from the designated pressure.

G. COMPACTION

1. Immediately after the bituminous mixture has been spread and struck off and the surface irregularities adjusted, it shall be thoroughly and uniformly compacted by rolling. Rolling shall be continued while the mixture is in a workable condition until all roller marks are eliminated and, unless otherwise designated on the plans, until a minimum of ninety-two (92) percent of the theoretical maximum specific gravity, as determined by an approved laboratory using AASHTO T 209, has been obtained. At the option of Engineer, density will be assessed through the use of cores or with a nuclear density gauge correlated to cores.
2. The number, weight, and type of rollers furnished shall be sufficient to obtain the required compaction without undue displacement, cracking, or shoving. Pneumatic tires shall be inflated to obtain the contact area pressures designated by Engineer.
3. Unless otherwise directed, rolling shall begin at the sides and proceed longitudinally parallel to the road centerline, each trip overlapping one-half of the roller width. Roller shall move at a slow, uniform speed with the drive wheels or rolls nearest the paver except on steep grades.

4. When the pavement is placed by machines in echelon or abutted against a previously placed lane, the longitudinal joint shall be rolled first, followed by the regular rolling procedure. On super-elevated curves, the rolling shall begin at the low side and progress to the high side by overlapping of longitudinal trips parallel to the centerline.
5. Any displacement occurring as a result of the reversing of the direction of a roller, or from other causes, shall be corrected at once by the use of rakes and addition of fresh mixture when required. Care should be exercised in rolling not to displace the line and grade of the edges of the bituminous mixture.
6. To prevent adhesion of the mixture to the rollers, the wheels shall be kept properly moistened with water or water mixed with very small quantities of detergent or other approved material. Excess liquid will not be permitted.
7. Along forms, curbs, headers, walls, and other places not accessible to the rollers, the mixture shall be thoroughly compacted with hot hand tampers, smoothing irons, or mechanical tampers. On depressed areas, a trench roller may be used, or cleated compression strips may be used under the roller to transmit compression to the depressed area.
8. Any mixture that becomes loose and broken, mixed with dirt, or is in any way defective shall be removed and replaced with fresh hot mixture, which shall be compacted to conform with the surrounding area. Any area showing an excess or deficiency of bituminous material shall be removed and replaced.

H. JOINTS

1. Placing of the bituminous paving shall be as continuous as possible. Rollers shall not pass over the unprotected end of a freshly laid mixture unless authorized by Engineer. Transverse joints shall be formed by cutting back on the previous run to expose the full depth of the course. When directed by Engineer, a brush of bituminous material shall be used on contact surfaces of transverse joints just before additional mixture is placed against the previously rolled material.

3.03

PROTECTION

- A. During any delays or suspensions of work, as outlined in the Contract Documents, Contractor shall be responsible for maintaining the quality of all leveling courses until the placement of additional courses. Maintenance of leveling courses because of delays or suspension of work will be done at Contractor's expense unless otherwise specified in the Contract Documents.

3.04

ACCEPTANCE

- A. The surface will be tested by Engineer using a 10-foot straightedge at selected locations. The variation of the surface from the testing edge of the straightedge between any two contacts with the surface shall at no point exceed three-sixteenths

inch. All humps or depressions exceeding the specified tolerance shall be corrected by removing defective work and replacing it with new material, or as directed.

- B. Mixture properties and gradation shall conform to the requirements shown in Subsection 2.01 above.
- C. Density shall conform to the requirements in Subsection 3.02(G)1 above.
- D. Engineer may isolate and reject obviously defective material without regard to testing procedures.

PART 4 METHOD OF MEASUREMENT AND BASIS OF PAYMENT

4.01 METHOD OF MEASUREMENT

- A. Plant mix bituminous pavement will be measured by the ton or the square yard, delivered and placed. In lieu of truck scales, batch weights will be permitted.
- B. Weigh tickets shall be issued for each load either by an automatic printer system as described under Subsection 3.01(F) herein, or by a weighman who witnesses the batches loaded into the hauling vehicles. In the case of a non-automatic plant, an inspector will be assigned to check the scales and metering devices during the batching process.
- C. The accumulative weight of all batches incorporated in the work will be used for payment. No deduction will be made for the weight of bituminous material in the mixture.
- D. When specified in the contract as pay items, the quantity of bituminous materials and commercial additive will be the number of tons of each used in the accepted work.

4.02 BASIS OF PAYMENT

- A. All work performed and measured as prescribed above will be paid for as provided in the respective sections for each type specified.
- B. Work prescribed in Subsection 3.01(A) herein will be paid for at the contract unit prices for the material used. Payment will be made under:

PAY ITEM	PAY UNIT
Plant Mix Bituminous Base	Ton or Square Yard
Plant Mix Bituminous Pavement	Ton or Square Yard
Plant Mix Wearing Course	Ton or Square Yard

END OF SECTION

SECTION 02520 — PORTLAND CEMENT CONCRETE PAVEMENT

PART 1 GENERAL

1.01 SUMMARY

- A. This work shall consist of constructing a pavement composed of Air-Entrained Portland Cement Concrete constructed on a prepared subgrade or base course in accordance with these specifications and in reasonably close conformity with the lines, grades, thicknesses, and typical cross sections shown on the plans or designated by Engineer.

1.02 RELATED WORK

- A. Section 02190, Aggregates
- B. Section 03304, Portland Cement Concrete
- C. Section 03305, Concrete Quality Control
- D. Section 03310, Concrete Work
- E. Section 03345, Concrete Finishing
- F. Section 03370, Concrete Curing

1.03 REFERENCES

- A. ASTM C150: Portland Cement
- B. ASTM C309: Liquid Membrane-Forming Compounds for Curing Concrete
- C. ASTM C311: Standard Test Methods for Sampling and Testing Fly Ash or Natural Pozzolans for Use in Portland-Cement Concrete
- D. ASTM C618: Standard Specifications for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
- E. ASTM C920: Elastomeric Joint Sealants
- F. ASTM D994: Preformed Expansion Joint Filler For Concrete (Bituminous Type)
- G. ASTM D1751: Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
- H. ASTM D1752: Preformed Sponge Rubber, Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction
- I. ASTM D2628: Preformed Polychloroprene Elastomeric Joint Seals for Concrete Pavements
- J. ASTM D2835: Lubricant for Installation of Preformed Compression Seals in Concrete Pavements

- K. ASTM D3542: Preformed Polychloroprene Elastomeric Joints Seals for Bridges
- L. ASTM D5249: Backer Material for Use with Cold- and Hot-Applied Joint Sealants in Portland Cement Concrete and Asphalt Joints
- M. ASTM D5893: Cold-Applied, Single-Component, Chemically Curing Silicone Joint Sealant for Portland Cement Concrete Pavements
- N. ASTM D6690: Joint and Crack Sealant, Hot Applied, for Concrete and Asphalt Pavements
- O. AASHTO M148: Liquid Membrane-Forming Compounds for Curing Concrete
- P. AASHTO M171: Sheet Materials for Curing Concrete
- Q. AASHTO M182: Burlap Cloth Made from Jute or Kenaf and Cotton Mats
- R. AASHTO M213: Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)

PART 2 PRODUCTS

2.01 MATERIALS

A. CONCRETE

- 1. Section 03304, Subsection 2.01, Cement
- 2. Section 03304, Subsection 2.07, Admixtures
- 3. Section 03304, Subsection 2.02, Water
- 4. Section 03304, Subsection 2.05, Fine Aggregate
- 5. Section 03304, Subsection 2.04, Coarse Aggregate
- 6. Section 03200, Subsection 2.01, Concrete Reinforcement Materials

B. JOINT FILLERS

- 1. The filler for each joint shall be furnished in a single piece for the full depth required for the joint unless otherwise authorized by Engineer. When the use of more than one piece is authorized for a joint, the abutting ends shall be fastened securely, and held accurately to shape by stapling or other positive fastening satisfactory to Engineer.
- 2. Preformed joint filler shall conform to the requirements of AASHTO M-213, ASTM D 994, ASTM D 1751 or ASTM D 1752 unless otherwise shown on the plans, and shall be punched to admit the dowels where called for on the plans.

C. JOINT SEALERS

- 1. Hot poured sealer for joints shall conform to the requirements of ASTM D6690 Type I Wyoming Modified unless otherwise shown on the plans.

2. Elastic joint sealer, where called for on the plans, shall be two component polyurethane sealant meeting ASTM C920, type M, grade NS, class 25, use T. Sealant for horizontal joints may be either Class A (self-leveling) or Class B (non-sag). Sealant for sloped or vertical joints shall be Class B.
3. Preformed compression joints shall be manufactured to the size and shape shown on the plans, from materials conforming to the requirements of ASTM D3542. Contractor shall furnish a certification for each shipment indicating that the material has been sampled, tested, and inspected in accordance with the provisions of ASTM D2628. Each certification so furnished shall be signed by an authorized agent of the manufacturer or independent testing agency. If recommended by the manufacturer, an approved lubricant-adhesive may be used to provide lubrication and bond for the joint. The lubricant shall be manufactured of material that is compatible with the sealer.
4. Silicone joint sealant shall conform to ASTM D5893, Type NS or SL Sealing Compound.
5. Backer Rod shall conform to ASTM D5249, type 1 or type 3. If used with hot-poured elastic sealant, the melting temperature shall be higher than the sealant's application temperature.

D. CURING MATERIALS

1. Burlap Cloth shall conform to AASHTO M-182, Class 3.
2. Waterproof Paper for Curing Concrete AASHTO M-171 (ASTM C-171)
3. Liquid Membrane-Forming Compounds for Curing Concrete AASHTO M-148 (ASTM C309), Type 2, Class B, white pigmented.

E. STOCKPILED AGGREGATES

1. Stockpiled materials shall meet the requirements of Section 02190, Subsection 3.01, STOCKPILED AGGREGATES.

PART 3 EXECUTION

3.01 PROPORTIONING CONCRETE MIX

- A. The concrete shall meet the following requirements:
1. Maximum slump of 3-1/2 inch.
 2. Design flexural strength as specified or shown on the drawings.
 3. The cement content shall not be less than 6.0 sacks per cubic yard with a maximum water-cement ratio of 0.47.
 4. Fly ash may be substituted for portland cement up to a maximum of 20 percent based on replacing 75 pounds of portland cement with 100 pounds of fly ash.

5. The percentage of air entrained in the mix shall be 4 - 7 percent.
 6. Pavement shall be class 4000 or higher.
- B. The mix proportions will be based upon trial mixes conducted by an Independent Testing Laboratory in accordance ACI 211. The proportions will be stated in terms of aggregates in a saturated, surface-dry condition, and the batch weights will have to be adjusted periodically to take into account the actual moisture content of the aggregates at time of use.
- C. The designated proportions shall govern during the progress of the work, except as provided below in paragraphs (1) through (3), inclusive.
1. If it is found impossible to obtain concrete of the desired plasticity and workability with the proportions originally approved by Engineer, he may approve changes in aggregate weights, provided that in no case shall the cement content originally designated be changed except as provided below.
 2. If it is found impossible to produce concrete having the required consistency without exceeding the maximum allowable water-cement ratio specified, the cement content shall be increased, or admixtures added as approved by Engineer so that the maximum water-cement ratio will not be exceeded.
 3. No change in the sources or character of the materials shall be made without due notice to Engineer, and no new materials shall be used until approved by Engineer and he has approved new proportions based upon Independent Laboratory tests and trial mixes.

3.02

EQUIPMENT

- A. The batching plant shall include bins, weighing hoppers, and scales for the fine aggregate and for each size of coarse aggregate. If cement is used in bulk, a bin, hopper, and separate scale for cement shall be included. The weighing hopper shall be properly sealed and vented to preclude dusting operation.
1. Bins and Hoppers - Bins with adequate separate compartments for fine aggregate and for each size of coarse aggregate shall be provided in the batching plant.
 2. Scales - The scales for weighing aggregates and cement shall be of either the beam type or the springless-dial type. They shall be accurate within 0.5 percent throughout the range of use. When beam-type scales are used, provision, such as a "telltale" dial, shall be made for indicating to the operator that the required load in the weighing hopper is being approached. A device on weighing beams shall indicate critical position clearly. Poises shall be designed to be secured in any position and to prevent inadvertent change. The weigh beam and "telltale" device shall be in full view of the operator while the hopper is charged, and he shall have convenient access to all controls. Weighing may be accomplished using electronic load cells and computer controls. Scales shall be tested as often as Engineer may

deem necessary to assure their continued accuracy. Contractor shall have on hand not less than ten 50-pound weights for frequent testing of all scales.

- B. Concrete may be mixed at the site of construction or at a central point, or wholly or in part in truck mixers. Each mixer shall have attached in a prominent place a manufacturer's plate showing the capacity of the drum in terms of volume of mixed concrete and the speed of rotation of the mixing drum or blades.
 - 1. Central plant mixers shall be capable of combining the aggregates, cement, and water into a thoroughly mixed and uniform mass within the specified mixing period, and of discharging and distributing the mixture without segregation on the prepared grade. The mixer shall be equipped with an approved timing device which will automatically lock the discharge lever when the drum has been charged and release it at the end of the mixing period. The mixers shall be cleaned at suitable intervals. The pickup and throw-over blades in the drum or drums shall be repaired or replaced when they are worn down 1 inch or more. Contractor shall: (1) have available at the job site a copy of the manufacturer's design, showing dimensions and arrangements of blades in reference to original height and depth; or (2) provide permanent marks on blade to show points of 1 inch wear from new condition. Drilled holes of 1/4-inch diameter near each end and at the midpoint of each blade are recommended.
 - 2. Truck Mixers and Truck Agitators - Truck mixers used for mixing and hauling concrete, and truck agitators used for hauling central mixed concrete shall conform to the requirements of ASTM C 94.
 - 3. Non-agitator Trucks - Bodies of non-agitating hauling equipment for concrete shall be smooth, mortar-tight, metal containers and shall be capable of discharging the concrete at a satisfactory controlled rate without segregation. The concrete shall be discharged from the Bottom of the container. If discharge of concrete is accomplished by tilting the body, the surface of the load shall be retarded by a suitable baffle. Covers shall be provided when needed for protection.
- C. The finishing machine shall be of an approved type. The finishing machine shall be of ample weight and power for proper finishing of the concrete. The finishing machine shall be designed and operated to strike off, screed and consolidate the concrete. Screed and float adjustments of these machines shall be checked at the start of each day's paving. Machines that cause displacement of side forms or frequent delays due to mechanical failure shall be replaced. When the finishing machines ride the edge of previously constructed slabs, provisions shall be made to protect the surface of these slabs.
- D. Vibrators, for full width vibration of concrete paving slabs, may be either the surface pan type or the internal type with either immersed tube or multiple spuds.
 - 1. Vibrators may be attached to the spreader or the finishing machine or may be mounted on a separate carriage.

2. Vibrators shall not come in contact with the joint, load transfer devices, subgrade, or side forms.
 3. The frequency of the surface vibrators shall not be less than 3,500 impulses per minute, and the frequency of the internal type shall not be less than 5,000 impulses per minute for tube vibrators and not less than 7,000 impulses per minute for spud vibrators. When spud-type internal vibrators, either hand-operated or attached to spreaders or finishing machines, are used adjacent to forms, they shall have a frequency of not less than 3,500 impulses per minute.
- E. Contractor shall provide sawing equipment adequate in number of units and power to complete the sawing with a water-cooled diamond edge saw blade or an abrasive wheel at the required rate. Contractor shall provide adequate artificial lighting facilities for night sawing. All of this equipment shall be on the job both before and continuously during concrete placement. A backup saw will be available.
- F. Straight side forms shall be made of a metal having a thickness of not less than 7/32-inch and shall be furnished in sections not less than 10 feet in length.
1. Forms shall have a depth at least equal to the prescribed edge thickness of the concrete, without horizontal joint, and a base width equal to not less than the depth of the forms.
 2. Flexible or curved forms of proper radius shall be used for curves of 100-foot radius or less. Flexible or curved forms shall be of a design acceptable to Engineer.
 3. Forms shall be provided with adequate devices for secure setting so that when in place they will withstand, without visible spring or settlement, the impact and vibration of the consolidating and finishing equipment.
 4. Flange braces shall extend outward on the base not less than 2/3 the height of the form.
 5. Forms with battered top surfaces, and bent, twisted, or broken forms shall be removed from the work. Repaired forms shall not be used until inspected and approved.
 6. Built-up forms shall not be used except where the total area of pavement of any specified thickness on the project is less than 2,000 square yards.
 7. The top face of the form shall not vary from a true plane more than 1/8 inch in 10 feet, and the upstanding leg shall not vary more than 1/4 inch.
 8. The forms shall contain provisions for locking the ends of abutting form sections together tightly, and secure setting.

3.03

PREPARATION OF GRADE

- A. After the base has been graded and compacted, in accordance with the provisions for the material specified, the grade shall be trimmed to an acceptable elevation.

3.04**SETTING FORMS**

- A. The foundations under the forms shall be hard and true to grade so that the form, when set, will be firmly in contact for its whole length and at the specified grade. Any grade which at the form line is found below established grade shall be filled to grade and thoroughly compacted. Imperfections or variations above grade shall be corrected by tamping or by cutting, as necessary.
- B. Forms shall be set sufficiently in advance of the point where concrete is being placed.
 - 1. After the forms have been set to correct grade, the grade shall be thoroughly tamped, mechanically or by hand, at both the inside and outside edges of the base of the forms.
 - 2. Forms shall be staked into place with not less than three pins for each 10-foot section. A pin shall be placed at each side of every joint.
 - 3. Form sections shall be tightly locked, free from play or movement in any direction. No excessive settlement or springing of forms under the finishing machine will be tolerated.
 - 4. Forms shall be cleaned and oiled prior to the placing of the concrete.
- C. The forms shall not deviate from true line by more than 1/4 inch at any point. The alignment and grade elevation of the forms shall be checked and corrections shall be made by Contractor immediately before the concrete is placed. When any form has been disturbed or any grade has become unstable, the form shall be reset and rechecked.
- D. In lieu of setting forms the edge of a previously placed concrete gutter section may be used as a form.

3.05**CONDITIONING OF SUBGRADE OR BASE COURSE**

- A. When side forms have been securely set to grade, the subgrade or base course shall be brought to proper cross section. Low areas may be filled with subgrade or base coarse material and compacted to the specified density, or filled with concrete integral with the pavement. The finished grade shall be maintained in a smooth and compacted condition until the pavement is placed.
- B. The subgrade or base course shall be uniformly moist when the concrete is placed. If it subsequently becomes too dry, the subgrade or base course shall be sprinkled, but the method of sprinkling shall not be such as to form mud or pools of water.
- C. No concrete shall be placed on frozen ground.

3.06**HANDLING, MEASURING, AND BATCHING MATERIALS**

- A. The batch plant site, layout, equipment, and provisions for transporting material shall be such as to assure a continuous supply of material to the work. Aggregates from different sources and of different grading shall not be stockpiled together.
- B. Aggregates shall be handled from stockpiles or other sources to the batching plant in such manner as to secure a uniform grading of the material. Aggregates that have become segregated or mixed with earth or foreign material shall not be used.
 - 1. All aggregates produced or handled by hydraulic methods, and washed aggregates, shall be stockpiled or binned for draining at least 12 hours before being batched. In case the aggregates contain high or non-uniform moisture content, storage or stockpile periods in excess of 12 hours may be required by Engineer.
 - 2. Rail shipment requiring more than 12 hours will be accepted as adequate binning only if the car bodies permit free drainage.
 - 3. The fine aggregate and each size of coarse aggregate shall be weighed into separate hoppers in the respective amounts set by the job mix.
- C. Cement shall be measured by the sack or by weight. Separate scales and hoppers shall be used for weighing the cement, with a device to indicate positively the complete discharge of the batch of cement into the mixer. Ninety-four pounds of bulk cement shall be considered one sack. Batches involving fractional sacks shall not be allowed, except when bulk cement is used.
- D. Fly ash shall be stored in a separate silo. If both cement and fly ash are used, they may be batched cumulatively provided portland cement is batched first.
- E. Methods and equipment for adding air-entraining agent or other admixtures into the batch, when required, shall be approved by Engineer. All admixtures shall be measured into the mixer with an accuracy of plus 3 percent.

3.07**MIXING CONCRETE**

- A. The concrete may be mixed at the site of the work, in a central-mix plant, or in truck mixers. The mixer shall be of an approved type and capacity.
- B. Ready-mix concrete shall be mixed and delivered in accordance with requirements of AASHTO M-157.
- C. When concrete is mixed in a central mixing plant, the mixing time shall not be less than recommended by the manufacturer unless tests can show the mix can be thoroughly mixed in less time. Mixing time shall be measured from the time all materials, except water, are in the drum. Transfer time in multiple drum mixers is included in mixing time.

1. The contents of an individual mixer drum shall be completely removed before a succeeding batch is emptied therein.
 2. The mixer shall be operated at a drum speed as shown on the manufacturer's name plate on the approved mixer.
 3. The batch shall be so charged into the drum that a portion of the mixing water shall enter in advance of the cement and aggregates. The flow of water shall be uniform, and all water shall be in the drum by the end of the first 15 seconds of the mixing period. The throat of the drum shall be kept free of such accumulations as may restrict the free flow of materials into the drum.
- D. Any concrete mixed less than the specified time shall be discarded and disposed of by Contractor at his expense.
- E. The volume of concrete mixed per batch shall not exceed the mixer's nominal capacity in cubic feet, as shown on the manufacturer's standard rating plate on the mixer, except that an overload up to ten percent above the mixer's nominal capacity may be permitted provided concrete test data for strength, segregation, and uniform consistency are satisfactory, and provided no spillage of concrete takes place.
- F. The time elapsing from the time water is added to the mix until the concrete is deposited in place at the site of the work shall not exceed:
1. 45 minutes when the concrete is hauled in non-agitating trucks.
 2. 90 minutes when hauled in truck mixers or truck agitators.
- G. Re-tempering concrete by adding water or by other means will not be permitted, except that when concrete is delivered in transit mixers or agitators, and when approved by Engineer. When additional water is added to the batch materials and additional mixing performed to increase the slump to meet the specified requirements, the following conditions must be met:
1. Water must be measured through a water meter.
 2. Maximum allowable water-cement ratio is not exceeded.
 3. Maximum allowable slump is not exceeded.
 4. Maximum allowable mixing and agitating time (or drum revolutions) are not exceeded.
 5. Concrete is remixed for at least half the minimum required mixing time or number of revolutions.
 6. Concrete that does not meet the above provisions shall be rejected.
- H. No concrete shall be mixed, placed, or finished when the natural light is insufficient, unless an adequate and approved artificial lighting system is operated.

- I. Unless otherwise authorized, the temperature of the mixed concreting operations shall be discontinued when a descending air temperature in the shade and away from artificial heat reaches 40°F and not resumed until an ascending air temperature in the shade away from artificial heat reaches 35°F.
- J. The temperature of the mixed concrete shall be not less than 50°F and not more than 90°F at the time of placing it in the forms.
 - 1. The mixing water may be heated to no more than 150°F.
 - 2. Aggregates may be heated by either steam or dry heat prior to being placed in the mixer. The apparatus used shall heat the mass uniformly and shall be so arranged as to preclude the possible occurrence of overheated areas which might injure the materials.

3.08 PLACING CONCRETE

- A. The concrete shall be deposited on the grade in such manner as to require as little re-handling as possible. Unless truck mixers, truck agitators, or non-agitating hauling equipment are equipped with means for discharge of concrete without segregation of the materials, the concrete shall be unloaded into an approved spreading device and mechanically spread on the grade in such manner as to prevent segregation of the materials. Placing shall be continuous between transverse joints without the use of intermediate bulkheads. Necessary hand spreading shall be done with shovels, not rakes. Worker shall not be allowed to walk in the freshly-mixed concrete with boots or shoes coated with earth or foreign substances.
- B. Where concrete is to be placed adjoining a previously constructed lane of pavement and mechanical equipment will be operated upon the existing lane of pavement, that lane shall have attained 80 percent of design strength. If only finishing equipment is carried on the existing lane, paving in adjoining lanes may be permitted after three days.
- C. Concrete shall be thoroughly consolidated against and along the faces of all forms and along the full length and on both sides of all joint assemblies, by means of vibrators inserted in the concrete. Vibrators shall not be permitted to come in contact with a joint assembly, the grade, or a side form. In no case shall the vibrator be operated longer than 15 seconds in any one location.
- D. Concrete shall be deposited as near to expansion and contraction joints as possible without disturbing them, but shall not be dumped from the discharge bucket or hopper onto a joint assembly unless the hopper is well centered on the joint assembly.

3.09 TESTING

- A. Contractor shall furnish the concrete necessary for testing and shall cooperate fully with Engineer in obtaining the material for testing purposes.

- B. The concrete shall be sampled, specimens made, and compliance determined in accordance with the following:
 - 1. Slump AASHTO T-119/ASTM C 143
 - 2. Air Content AASHTO T-152/ASTM C 231
 - 3. Unit Weight AASHTO T-121/ASTM C 138
 - 4. Strength (compressive) AASHTO T-22/ASTM C 39 (flexural, third point) AASHTO T-97/ASTM C 78
 - 5. Making and Curing Test Specimens in the Field AASHTO T-23/ASTM C 31
- C. Tests will be performed on all pours over 20 cubic yards. Slump, Air Content and Unit Weight tests will be performed every 150 cubic yards. For strength testing, one group of test specimens will be made during the first half of each shift and another group of test specimens will be made during the last half of each shift. Test ages will be 7 and 28 days.
- D. All testing will be pre-formed by an ACI certified technician.

3.10

STRIKEOF OF CONCRETE AND PLACEMENT OF REINFORCEMENT

- A. Following the placing of the concrete, it shall be struck off to conform to the cross section shown on the plans and to an elevation such that when the concrete is properly consolidated and finished, the surface of the pavement will be at the elevation shown on the plans or established by Engineer.
- B. When reinforced concrete pavement is placed in two layers, the entire width of the bottom layer shall be struck off to such length and depth that the sheet of fabric or bar mat may be laid full length on the concrete in its final position without further manipulation. The reinforcement shall then be placed directly upon the concrete, after which the top layer of the concrete shall be placed, struck off, and screeded. Any portion of the bottom layer of concrete which has been placed more than 30 minutes without being covered with the top layer shall be removed and replaced with freshly mixed concrete at Contractor's expense.
- C. When reinforced concrete is placed in one layer, the reinforcement may be positioned in advance of concrete placement or it may be placed by mechanical or vibratory means in plastic concrete, after the concrete is spread.
- D. Reinforcing steel shall be free from dirt, oil, paint, grease, mill scale, and loose or thick rust which would impair bond of the steel with the concrete.

3.11

JOINTS

- A. Joints shall be constructed of the type and dimensions, and at the locations required by the plans or special provisions.

- B. Bars shall be placed by approved mechanical equipment or rigidly secured by chairs or other approved supports to prevent displacement.
- C. Tie bars shall not be painted or coated with asphalt or other material, or enclosed in tubes or sleeves.
- D. Dowels, when used as load transfer devices, shall be held in position parallel to the surface and centerline of the slab by a metal device that is left in the pavement.
 - 1. One half of each dowel shall be painted with one coat of lead or tar paint, to prevent the concrete from binding to that portion of the dowel.
 - 2. An approved metal dowel cap or sleeve shall be furnished for each dowel bar used with the expansion joints. The caps or sleeves shall fit the dowel bar tightly.
 - 3. In lieu of using dowel assemblies at contraction joints, dowel bars may be placed in the full thickness of pavement by a mechanical device approved by Engineer.
- E. Sawed joints shall be cut by means of concrete saws with diamond blades or other approved equipment to the depth, width, and line shown on the plans.
 - 1. Sawing of the joints shall commence as soon as the concrete has hardened sufficiently to permit sawing without excessive raveling, usually 4 to 24 hours. All joints shall be sawed before uncontrolled shrinkage cracking takes place. If necessary, the sawing operations shall be carried on both during the day and night, regardless of weather conditions. The sawing of any joint shall be omitted if a crack occurs at or near the joint location prior to the time of sawing, and sawing shall be discontinued when a crack develops ahead of the saw. In general, all joints should be sawed in sequence. Where the saw cut was discontinued because of interference of the form the saw cut must be completed when the form is stripped.
 - 2. Suitable guide lines or devices shall be used to assure cutting the joint as shown on the plans.
 - 3. The saw cut shall not vary by more than 1/4 inch in 10 feet.
 - 4. When shown on the plans, a second shallower cut must be made to provide adequate space for joint sealer. This sawing may commence as soon as the concrete has hardened sufficiently to permit cutting without chipping, spalling or tearing.
- F. When approved by Engineer joints may be cut into the fresh concrete with a finishing tool. This tool must be capable of cutting to the depth specified.
 - 1. Suitable guidelines or devices shall be used to assure cutting the joint as shown on the plans.
 - 2. The cut shall not vary by more than 1/4 inch in 10 feet.

- G. LONGITUDINAL JOINTS. Deformed steel tie bars of specified length, size, spacing, and material shall be placed perpendicular to the longitudinal joints when shown on the plans.
1. When adjacent lanes of pavement are constructed separately, steel side forms shall be used which will form a keyway along the construction joint or dowels shall be installed at the spacing and size shown on the drawings. Tie bars or load transfer bars may be installed through holes in the forms or approved two-piece connectors may be used.
 2. Longitudinal contraction joints shall consist of planes of weakness created by cutting grooves in the surface of the pavement and, when shown on the plans, shall include load transfer assemblies.
- H. TRANSVERSE EXPANSION JOINTS - The expansion joint filler shall be continuous from form to form, shaped to the subgrade. Damaged or repaired joint filler shall not be used unless approved by Engineer.
1. The expansion joint filler shall be held in a vertical position. An approved installing bar, or other device, shall be used if required to secure preformed expansion joint filler at the proper grade and alignment during placing and finishing of the concrete.
 2. Finished joints shall not deviate more than 1/4 inch in the horizontal alignment from a straight line.
 3. If joint fillers are assembled in section, there shall be no offsets between adjacent units.
 4. No plugs of concrete shall be permitted anywhere within the expansion space.
- I. TRANSVERSE CONTRACTION JOINTS - Transverse contraction joints shall consist of planes of weakness created by cutting grooves in the surface of the pavement and, when shown on the plans, shall include load transfer assemblies.
- J. When directed by Engineer, random cracks shall be routed or sawed and filled with joint sealer. Care shall be taken so that the depth of cut is uniform.
- K. TRANSVERSE FORMED CONTRACTION JOINTS - These joints shall comply with the requirements of Subsection 3.11(G) for the longitudinal formed joint.
- L. TRANSVERSE CONSTRUCTION JOINT - Transverse construction joints shall be constructed when there is an interruption of more than 30 minutes in the concreting operations. No transverse joint shall be constructed within 5 feet of an expansion joint, contraction joint, or plane of weakness. If sufficient concrete has not been mixed at the time of interruption to form a slab at least 5 feet long, the excess concrete back to the last preceding joint shall be removed and disposed of as directed.

- A. The sequence of operations shall be the strike-off and consolidation, floating and removal of laitance, straight-edging, and final surface finish.
- B. First, the concrete shall be consolidated and struck off.
 - 1. Unless otherwise permitted for small areas or for short periods of time due to equipment failure, all pavement concrete shall be consolidated using vibrators for full width of paving slabs.
 - 2. Concrete adjacent to joints shall be mechanically vibrated, also under and around all load transfer devices, joint assembly units, and other features designed to extend into the pavement.
 - 3. After the concrete has been placed and vibrated adjacent to the joints as required, the finishing machine shall be brought forward, operating in a manner to avoid damage to or misalignment of joint devices.
- C. After the concrete has been struck off and consolidated, it shall be further smoothed, trued, and consolidated, by means of a longitudinal float, by the use of one of the following methods as specified or permitted:
 - 1. Hand Method - The hand-operated longitudinal float shall be not less than 12 feet in length and 6 inches in width, properly stiffened to prevent flexibility and warping. The longitudinal float, operated from foot bridges resting on the side forms and spanning but not touching the concrete, shall be worked with a sawing motion, while held in a floating position parallel to the road centerline, and shall be passed gradually from one side of the pavement to the other. Movement ahead along the centerline of the pavement shall be in successive advances of not more than one-half the length of the float. Any excess water or soupy material shall be wasted over the side forms on each pass.
 - 2. Mechanical Method - The mechanical longitudinal float shall be of a design approved by Engineer and shall be in good working condition. The tracks from which the float operates shall be securely adjusted to the required crown. The float shall be accurately adjusted and coordinated with the adjustments of the transverse finishing machine so that a small amount of mortar is carried ahead of the float at all times. The forward speed shall be adjusted so that the float will lap the distance specified by Engineer on each transverse trip. The float shall pass over each area of pavement at least two times, but excessive operation over a given area will not be permitted. Any excess water or soupy material shall be wasted over the side forms on each pass.
 - 3. Alternative Mechanical Method - As an alternative to Item (2) above, Contractor may use a machine composed of a cutting and smoothing float, or floats, suspended from and guided by a rigid frame. This frame shall be carried by four or more visible wheels riding on, and constantly in contact with, the side forms.

4. If necessary, following one of the preceding methods of floating, long handled floats having blades not less than five feet) in length and six inches in width may be used to smooth and fill in open-textured areas in the pavement. Long handled floats shall not be used to float the entire surface of the pavement in lieu of, or supplementing, one of the preceding methods of floating. When strike-off and consolidation are done by the hand method and the crown of the pavement will not permit the use of the longitudinal float, the surface shall be floated transversely by means of the long handled float. Care shall be taken not to work the crown out of the pavement during the operation. After floating, any excess water and laitance shall be removed from the surface of the pavement by a straightedge 10 feet or more in length. Successive drags shall be lapped one-half of the length of the blade.
- D. After the floating has been completed and the excess water removed, but while the concrete is still plastic, the surface of the concrete shall be tested for trueness with a ten-foot straightedge. For this purpose Contractor shall furnish and use an accurate 10-foot straightedge swung from handles 3 feet longer than $1/2$ the width of the slab. The straightedge shall be held in contact with the surface in successive positions parallel to the road centerline and the whole area gone over from one side of the slab to the other, as necessary. Advance along the road shall be in successive stages of not more than $1/2$ the length of the straightedge. Any depressions found shall be immediately filled with freshly mixed concrete, struck off, consolidated, and refinished. High areas shall be cut down and refinished. Special attention shall be given to assure that the surface across joints meets the requirements for smoothness. Straightedge testing and surface corrections shall continue until the entire surface is found to be free from observable departures from the straightedge and the slab conforms to the required grade and cross section.
- E. The final finish will be specified on the plans as to the type of surface texture. The following types of surface textures may be specified:
 1. Type I - Transverse Tining - The mainline finish shall be produced by mechanical equipment described as follows: The transverse grooving machine shall be either a vibrating roller or a comb equipped with steel tines. The machine shall be self-propelled and shall automatically lift the roller or tine comb at the end of the pavement. Hand grooving methods will be permitted in a manner approved by Engineer in those areas where the mechanical equipment cannot be used. This equipment shall have rectangular or circular shaped spring steel tines which are randomly spaced at $1/2$ to 1 inch intervals from center to center. The grooves shall be made perpendicular to the center line of the pavement and the resulting transverse grooves shall be .090 to .125 inches wide and shall be $1/8$ to $3/16$ inch deep. Acceleration lanes, deceleration lanes, and irregular sections may be finished by methods other than mechanical provided they produce a similar type of transverse groove.

2. Type II - Longitudinal Tining - The mainline finish shall be produced by mechanical equipment described as follows: The longitudinal grooving machine shall be either a vibrating roller or a comb equipped with steel tines. The machine shall be self-propelled and shall automatically lift the roller or tine comb at the end of the pavement. Hand grooving methods will be permitted in a manner approved by Engineer in those areas where the mechanical equipment cannot be used. This equipment shall have rectangular or circular shaped spring steel tines which are randomly spaced at 1/2 to 1 inch intervals from center to center. The grooves shall be made parallel to the center line of the pavement and the resulting longitudinal grooves shall be 0.090 to 0.125 inch wide and shall be 1/8 to 3/16 inch deep. The mechanical equipment shall be operated from a bridge when the pavement is 16 feet or more in width. Acceleration lanes, deceleration lanes, and irregular sections may be finished by methods other than mechanical, provided they produce a similar type of longitudinal groove.
3. Type III - Artificial Grass Drag - The pavement finish shall be produced by a nylon or artificial grass drag as approved by Engineer. A uniform surface of gritty texture shall be produced by pulling the drag longitudinally. For a pavement width of 16 feet or more in width, the drag shall be mounted on a bridge which travels on the forms. The drag shall be at least 3 feet wide and in full contact with the full width of the pavement. Drags shall be maintained clean and free from encrusted mortar. Drags that cannot be cleaned shall be discarded and new ones substituted.
4. Type IV - Bristle Broom - The surface texture produced by a broom shall be applied when the water sheen has practically disappeared. The broom shall be drawn from the center to the edge of the pavement with adjacent strokes slightly overlapping. The brooming operation shall be so executed that the corrugations produced in the surface shall be uniform in appearance and shall have a minimum depth of approximately 1/16 inch and a maximum depth of approximately 1/8 inch. Brooming shall be completed before the concrete is in such condition that the surface will be torn or unduly roughened by the operation. The finished surface shall be free from rough and porous areas, irregularities and depressions resulting from improper handling of the broom. Mechanical brooming, in lieu of the manual brooming, will be permitted if satisfactory results can be obtained.
5. Type V - Belt Finish (Paving with Rigid Forms) - When straight-edging is complete and the water sheen has practically disappeared and just before the concrete becomes non-plastic, the surface shall be belted with a two-ply canvas belt not less than eight inches wide and at least three feet longer than the pavement width. Hand belts shall have suitable handles to permit controlled, uniform manipulation. The belt shall be operated with short strokes transverse to the road centerline and with a rapid advance parallel to the centerline.
6. Type VI - Burlap Drag - The drag shall be a seamless strip of damp burlap or cotton fabric which shall produce a uniform surface of a gritty nature after dragging it longitudinally along the full width of pavement. For pavement 16 feet or more in

width, the drag shall be mounted on a bridge which travels on the forms. The dimensions of the drag shall be such that a strip of burlap or fabric, at least three feet wide, is in contact with the full width of pavement surface while the drag is used. Drags shall be maintained clean and free from encrusted mortar. Drags that cannot be cleaned shall be discarded and new drags shall be substituted.

- F. After the final finish, but before the concrete has taken its initial set, the edges of the pavement along each side of each slab, and on each side of transverse expansion joints, formed joints, transverse construction joints, and emergency construction joints shall be worked with an approved tool and rounded to a radius of 1/4 inch.
 - 1. A well-defined and continuous radius shall be produced, and a smooth, dense mortar finish shall be obtained. The surface of the slab shall not be unduly disturbed by tilting of the tool during use.
 - 2. At all joints, any tool marks appearing on the slab adjacent to the joints shall be eliminated by texturing the surface. The rounding of the corner of the slab shall not be disturbed when the surface is textured. All concrete on top of the joint filler shall be completely removed.
 - 3. All joints shall be tested with a straightedge before the concrete has set, and correction shall be made if one side of the joint is higher than the other or if an edge is higher or lower than the adjacent slabs.
- G. If the application of water to the surface is permitted, it shall be applied as a fog spray by means of approved spray equipment.
- H. Unless otherwise specified, hand finishing methods will not be permitted except under the following conditions:
 - 1. In the event of breakdown of the mechanical equipment, hand methods may be used to finish the concrete already deposited on the grade when the breakdown occurs.
 - 2. Narrow widths or areas of irregular dimensions where operation of the mechanical equipment is impractical may be finished by hand methods.
 - 3. Concrete, as soon as placed, shall be struck off and screeded. An approved portable screed shall be used. In operation the screed shall be moved forward on the forms with a combined longitudinal and transverse shearing motion, moving always in the direction in which the work is progressing and so manipulated that neither end is raised from the side forms during the striking off process. If necessary, this shall be repeated until the surface is of uniform texture, true to grade and cross section, and free from porous areas.
 - 4. The screed for the surface shall be at least 2 feet longer than the maximum width of the slab to be struck off. It shall be of approved design, sufficiently rigid to retain its shape, and shall be constructed either of metal or other suitable material shod with metal.

5. Consolidation shall be attained by the use of a suitable vibrator or other approved equipment.

3.13 SURFACE TEST

- A. As soon as the concrete has hardened sufficiently, the pavement surface shall be tested with a 10-foot straightedge or other specified devices.
 1. Areas showing high spots of more than 1/4 inch, but not exceeding 1/2 inch in 10 feet, shall be marked and immediately ground down with an approved grinding tool to an elevation where the area or spot will not show surface deviations in excess of 1/4 inch when tested with a 10-foot straightedge. Grinders shall be of the stacked head, vertical blade type that will not polish or smooth the surface but will provide a coefficient of friction approximately equal to that of the unground pavement. Grinding grooves shall be kept parallel with the direction of travel.
 2. Where the departure from correct cross section exceeds 1/2 inch, the pavement shall be removed and replaced by and at the expense of Contractor. Any area or section so removed shall be neither less than 5 feet in length nor less than the full width of the lane involved. When it is necessary to remove and replace a section of pavement, any remaining portion of the slab adjacent to the joints that is less than 5 feet in length shall also be removed and replaced.

3.14 CURVING

- A. Immediately after the finishing operations have been completed and as soon as marring of the concrete will not occur, the entire surface of the newly placed concrete shall be covered and cured in accordance with one of the following methods.
 1. COTTON OR BURLAP MATS - The surface of the pavement shall be entirely covered with mats. The mats used shall be of such length (or width) that as laid they will extend at least twice the thickness of the pavement beyond the edges of the slab. The mat shall be placed so that the entire surface and both edges of the slab are completely covered. Prior to being placed, the mats shall be saturated thoroughly with water. The mats shall be so placed and weighed down as to cause them to remain in intimate contact with the surface covered, and the covering shall be maintained fully wetted and in position for 72 hours after the concrete has been placed, unless otherwise specified.
 2. WATERPROOFED PAPER - The top surface and sides of the pavement shall be entirely covered with waterproofed paper. The units shall be lapped at least 18 inches. The paper shall be so placed and weighted down as to cause it to remain in intimate contact with the surface covered. The paper shall be of such dimensions that each unit as laid will extend beyond the edges of the slab at twice the thickness of the pavement or shall be of pavement width and 2-foot strips of paper provided for the edges. If laid longitudinally, paper not manufactured in sizes which will provide this width shall be securely sewed or cemented together,

the joints being securely sealed in such a manner that they do not open up or separate during the curing period. Unless otherwise specified, the covering shall be maintained in place for 72 hours after the concrete has been placed. The surface of the pavement shall be thoroughly wetted prior to the placing of the paper.

3. WHITE PIGMENTED IMPERVIOUS MEMBRANE - The entire surface of the pavement shall be sprayed uniformly with white pigmented curing compound immediately after the finishing of the surface and before the set of the concrete has taken place, or if the pavement is cured initially with burlap or cotton mats, the curing compound may be applied upon removal of the mats.

- a. The curing compound shall not be applied during rainfall.
- b. Curing compound shall be applied under pressure at the rate of approximately 1 gallon to 150 square feet by mechanical sprayers. The spraying equipment shall be of the fully atomizing type equipped with a tank agitator. At the time of use, the compound shall be in a thoroughly mixed condition with the pigment uniformly dispersed throughout the vehicle. During the application the compound shall be stirred continuously by effective mechanical means. Hand spraying of odd widths or shapes and on concrete surfaces exposed by the removal of forms will be permitted. Curing compound shall be applied to the inside faces of joints to be sealed.
- c. Should the film become damaged from any cause within the required curing period, the damaged portions shall be repaired immediately with additional compound.
- d. Upon removal of side forms, the sides of the slabs exposed shall be protected immediately to provide a curing treatment equal to that provided for the surface.

4. WHITE POLYETHYLENE SHEETING - The top surface and sides of the pavement shall be entirely covered with polyethylene sheeting. The units used shall be lapped at least 18 inches. The sheeting shall be so placed and weighted down as to cause it to remain in intimate contact with the surface covered. The sheeting as prepared for use shall have such dimension that each unit as laid will extend beyond the edges of the slab at least twice the thickness of the pavement. Unless otherwise specified, the covering shall be maintained in place for 72 hours after the concrete has been placed.

- B. Failure to provide sufficient cover material of whatever kind Contractor may elect to use, or lack of water to adequately take care of both curing and other requirements, shall be cause for immediate suspension of concreting operations. The concrete shall not be left exposed for more than 1/2 hour between stages of curing or during the curing period.

- C. When concrete is being placed and the average daily temperature is below 40°F or the air temperature may be expected to drop below 35°F, a sufficient supply of straw, hay, grass, or other suitable blanketing material shall be spread over the pavement to a sufficient depth to prevent freezing of the concrete. The period of time such protection shall be maintained shall be not less than ten days or until the concrete has reached full strength. Contractor shall be responsible for the quality and strength of the concrete placed during cold weather, and any concrete injured by frost action shall be removed and replaced at Contractor's expense.

3.15 REMOVING FORMS

- A. Forms shall not be removed from freshly placed concrete until it has set for at least 12 hours, except auxiliary forms used temporarily in widened areas.
- B. Forms shall be removed carefully so as to avoid damage to the pavement. After the forms have been removed, the sides of the slab shall be cured as outlined in one of the methods indicated above.
- C. Major honeycombed areas will be considered as defective work and shall be removed and replaced. Any area or section so removed shall not be less than 5 feet in length or less than full width of the lane involved. When it is necessary to remove and replace a section of pavement, any remaining portion of the slab adjacent to the joints that is less than 5 feet in length shall also be removed and replaced.

3.16 SEALING JOINTS

- A. When joints are specified to be sealed on the plans, they shall be filled with joint-sealing material before the pavement is opened to traffic and as soon after completion of the curing period as is feasible.
- B. Just prior to sealing, each joint shall be thoroughly cleaned of all foreign material, including membrane curing compound, and the joint faces shall be clean and surface dry when the seal is applied.
- C. Material for seal shall be installed in accordance with the manufacturer's recommendations. A copy of the instructions shall be submitted to Engineer for information.
- D. The sealing material shall be applied to each joint opening to conform to the details shown on the plans or as directed by Engineer.
- E. The pouring shall be done in such a manner that the material will not be spilled on the exposed surfaces of the concrete. Any excess material on the surface of the concrete pavement shall be removed, and the pavement surface shall be cleaned. The use of sand or similar material as a cover for the seal will not be permitted.
- F. Poured joint-sealing material shall not be placed when the air temperature in the shade is less than 50°F, unless approved by Engineer.

3.17**PROTECTION OF PAVEMENT**

- A. Contractor shall protect the pavement and its appurtenances against both public traffic and traffic caused by his own employees and agents. This shall include watchmen to direct traffic and the erection and maintenance of warning signs and lights. He will indicate the location and type of device or facility required to protect the work and provide adequately for traffic.
- B. In order that the concrete may be properly protected against the effects of rain before the concrete is sufficiently hardened, Contractor will be required to have available at all times materials for the protection of the edges and surface of the unhardened concrete. Such protection materials shall consist of standard metal forms or wood plank having a nominal thickness of not less than two inches and a nominal width of not less than the thickness of the pavement at its edge for the protection of the pavement edges, and covering material such as burlap or cotton mats, curing paper, or plastic sheeting material for the protection of the surface of the pavement. When rain appears imminent, all paving operations shall stop and all available personnel shall begin placing forms against the side of the pavement and covering the surface of the unhardened concrete with the protective covering.
- C. Any damage to the pavement occurring prior to final acceptance or opening to traffic shall be repaired or the pavement shall be replaced.

3.18**OPENING TO TRAFFIC**

- A. Engineer shall decide when the pavement shall be opened to traffic.
- B. Prior to being opened to traffic, the pavement shall be cleaned and all pavement markings shall be in place.

3.19**CONCRETE PAVEMENT – SLIPFORM METHOD**

- A. GRADE - After the grade or base has been placed and compacted to the required density, the grade and areas which are to support the paving machine shall be cut to the proper elevation by means of an approved fine-grading machine.
 - 1. The fine-grading machine shall be of sufficient weight and shall be either self-propelled or towed by sufficient power to trim the compacted material without gouging or tearing the surface.
 - 2. The machine shall have cutting edges or surface shavers controlled from an independent control reference wire by means of an automatic control device.
 - 3. To avoid excessive depths of cut the machine may accomplish the fine grading by means of successive passes with each pass controlled from the independent reference line through the automatic control.
 - 4. If the density of the base is disturbed by the grading operations, it shall be corrected by additional compaction before concrete is placed.

5. The grade shall be constructed sufficiently in advance of the placing of the concrete. If any traffic is allowed to use the prepared grade, the grade shall be checked and corrected immediately ahead of the placing of the concrete.
- B. PLACING CONCRETE - The concrete shall be placed with an approved slip-form paver designed to spread, consolidate, screed, and float-finish the freshly placed concrete in one complete pass of the machine in such manner that a minimum of hand finish will be necessary to provide a dense and homogenous pavement in conformance with the plans and specifications.
1. The machine shall vibrate the concrete for the full width and depth of the strip of pavement being placed. Such vibrations shall be accomplished with vibrating tubes or arms working in the concrete, or with a vibrating screed or pan operating on the surface of the concrete.
 2. The sliding forms shall be rigidly held together laterally to prevent spreading of the forms. The forms shall trail behind the paver for such a distance that no appreciable slumping of the concrete will occur.
 3. The concrete shall be held at a uniform consistency, having a slump of not more than two inches.
 4. The slip-form paver shall be operated with as nearly a continuous forward movement as possible, and all operations of mixing, delivering, and spreading concrete shall be so coordinated as to provide uniform progress with stopping and starting of the paver held to a minimum. If, for any reason, it is necessary to stop the forward movement of the paver, the vibratory and tamping elements shall also be stopped immediately. No tractive force shall be applied to the machine, except that which is controlled from the machine.
- C. The surface smoothness and texture shall meet the requirements of Section 02520, Subsection 3.12, FINAL STRIKEOFF, CONSOLIDATION, AND FINISHING, Part E, and Section 02520, Subsection 3.13, SURFACE TEST.
- D. Curing shall be done in accordance with one of the methods included in Section 02520, Subsection 3.14, CURING. The curing material shall be applied at the appropriate time and shall be applied uniformly and completely at all surfaces and edges of the pavement.
- E. All joints shall be constructed in accordance with Section 02520, Subsection 3.11, JOINTS.

3.20

TOLERANCE IN PAVEMENT THICKNESS

- A. The thickness of the pavement shall be determined by average caliper measurement of cores tested.
- B. For the purpose of establishing an adjusted unit price for pavement, a minimum of two cores per mile per lane or areas such as intersections, entrances, crossovers,

ramps, etc., will be considered as one unit and the thickness of each unit will be determined separately. Small irregular unit areas may be included as part of another unit. At such points as Engineer may select in each unit, one core will be taken for each 1,000 square yards of pavement, or fraction thereof, in the unit. Should any thickness deviation be found, additional cores may be taken to define the horizontal limits of the deviation.

- C. When the measurement of the core from a unit is not deficient more than 0.2 inch from the plan thickness, full payment will be made.
- D. When such measurement is deficient more than 0.2 inch and not more than 1.0 inch from the plan thickness, 2 additional cores at intervals not less than 300 feet will be taken and used in the average thickness for that unit.
- E. In calculations for the average thickness of the pavement, measurements which are in excess of the specified thickness by more than 0.2 inch will be considered as the specified thickness plus 0.2 inch, and measurements which are less than the specified thickness by more than 1 inch will not be included in the average.
- F. When the measurement of any core is less than the plan thickness by more than 1 inch, the actual thickness of the pavement in this area will be determined by taking additional cores at not less than 10-foot intervals parallel to the centerline in each direction from the affected location until in each direction a core is found which is not deficient by more than 1 inch. Areas found deficient in thickness by more than 1 inch shall be evaluated by Engineer; if in his judgment the deficient areas warrant removal, they shall be removed and replaced with concrete of the thickness shown on the plans. Exploratory cores for deficient thickness will not be used in averages for adjusted unit prices.

3.21 REPAIR OF DEFECTIVE PAVEMENT SLABS

- A. Spalls along joints shall be replaced by saw cutting at least 1/2 inch outside the spalled area and to a minimum of 2 inches. The area shall be chipped out at least 3 inches to solid concrete and then cleaned with compressed air sandblasting. First, the surface of the cavity shall be coated with an approved epoxy-resin binder. Then the cavity shall be filled with an approved non-shrink grout.
- B. Random cracks that occur away from joints and, in the judgment of Engineer, will not cause future maintenance problems may be routed and sealed. If not accepted, the slab shall be replaced at Contractor's expense.

PART 4 METHOD OF MEASUREMENT AND BASIS OF PAYMENT

4.01 METHOD OF MEASUREMENT

- A. The quantity of pavement laid shall be the number of square yards of full depth pavement. The number of square yards shall be determined by Engineer after construction of the pavement has been completed.

- A. The quantity of accepted pavement shall be measured as above provided and shall be paid for at the contract unit price per square yard bid as called for in the proposal. This price shall constitute full compensation for furnishing and preparation of all materials, including all joints, joint filler, dowels, and reinforcing if required in the construction drawings or special provisions; placing, finishing, curing; and all labor, equipment, tools and incidentals necessary to complete these items.
- B. Payment will be made under: Concrete Pavement Sq. Yd.
- C. CONCRETE PAVEMENT DEFICIENCY:
1. Where the average thickness of pavement is deficient in thickness by more than 0.2 inch, but not more than 1 inch, payment will be made at an adjusted price as specified in the following table:

Deficiency in thickness as determined by cores	Proportional part of contract price
Inches	Percentage Allowed
0.00 to 0.20	100 percent
0.21 to 0.30	80 percent
0.31 to 0.40	72 percent
0.41 to 0.50	68 percent
0.51 to 0.75	57 percent
0.76 to 1.00	50 percent

- D. When thickness of pavement is deficient by more than 1 inch and the judgment of Engineer is that the area of such deficiency should not be removed and replaced, there will be no payment for the area retained.

END OF SECTION

SECTION 02528 — CONCRETE CURBS AND COMBINED CURBS AND GUTTERS

PART 1 GENERAL

1.01 SUMMARY

- A. Curbs or combined curbs and gutters shall consist of air-entrained portland cement concrete constructed in accordance with these specifications. This work shall be in reasonably close conformity with the lines and grades, thicknesses, and typical cross sections shown on the plans or established by Engineer.
- B. Concrete curbs and combined curbs and gutters shall be constructed to meet requirements of American with Disabilities Act, when applicable.

1.02 RELATED WORK

- A. Section 03304, Portland Cement Concrete
- B. Section 03200, Concrete Reinforcement
- C. Section 03370, Concrete Curing

1.03 REFERENCES

- A. AASHTO M213: Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
- B. ASTM D994: Preformed Expansion Joint Filler for Concrete (Bituminous Types).
- C. ASTM D1751: Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).
- D. ASTM D1752: Preformed Sponge Rubber, Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction.

PART 2 PRODUCTS

2.01 MATERIALS

- A. PORTLAND CEMENT CONCRETE - Air-entrained Portland Cement Concrete shall conform to the requirements of Section 03304, Subsection 2.07, Class 4000.
- B. REINFORCING STEEL - Reinforcing steel shall conform to the requirements of Section 03200, CONCRETE REINFORCEMENT.
- C. PREFORMED EXPANSION JOINT MATERIAL - Joint material shall comply with the requirements of AASHTO M213, ASTM D994, ASTM D1751, or ASTM D1752.

PART 3 EXECUTION

3.01 GENERAL

- A. Curbs and curb and gutter shall be constructed at the locations shown on the plans and where directed by Engineer and shall be in accordance with these specifications and plans.

3.02 SUBGRADE AND BASE COARSE PREPARATION

- A. The subgrade shall be excavated or filled with suitable material to the required grades and lines.
- B. All soft, yielding, and otherwise unsuitable material shall be removed and replaced with suitable material. Filled sections shall be compacted and extend a minimum of 2 feet outside the form lines.
- C. The subgrade shall be 95 percent of maximum dry density as determined by AASHTO T180 modified proctor density.
- D. When required on the plans base coarse will be installed to the required grade in accordance with Section 02231, Subsection 3.03.

3.03 CONCRETE PLACEMENT

- A. The concrete shall be placed either by an approved slip-form/extrusion machine, by the formed method, or by a combination of these methods.
- B. The slip-form/extrusion machine approved shall be so designed as to place, spread, consolidate, screed, and finish the concrete in one complete pass in such a manner that a minimum of hand finishing will be necessary to provide a dense and homogeneous concrete section.
 - 1. The machine shall shape, vibrate, and/or extrude the concrete for the full width and depth of the concrete section being placed.
 - 2. It shall be operated with as nearly a continuous forward movement as possible. All operations of mixing, delivery, and spreading concrete shall be so coordinated as to provide uniform progress, with stopping and starting of the machine held to a minimum.
- C. The formed method shall consist of setting forms, placing concrete and finishing.
 - 1. Form material shall be straight and free from warp, having sufficient strength to resist the pressure of the concrete without displacement and sufficient tightness to prevent the leakage of mortar. Flexible or rigid forms of proper curvature may be used for curves having a radius of 100 feet or less. Division plates shall be metal.

2. The front and back forms shall extend for the full depth of the concrete. All of the forms shall be braced and staked so that they remain in both horizontal and vertical alignment until their removal.
3. They shall be cleaned and coated with an approved form-release agent before concrete is placed against them.
4. The concrete shall be deposited into the forms without segregation and then it shall be tamped and spaded or mechanically vibrated for thorough consolidation.
5. Low roll or mountable curbs may be formed without the use of a face form by using a straightedge and template to form the curb face. When used, face forms shall be removed as soon as possible to permit finishing.
6. Front and back forms may be removed at such time as the concrete is sufficiently set that removal will not chip, spall or otherwise damage the concrete. When forms are removed before the expiration of the curing period, the edges of the concrete shall be protected with curing compound.

3.04 FINISHING

- A. The surface of the concrete shall be finished true to the lines and grades shown on the plans.
- B. Concrete shall be worked until the coarse aggregate is forced down into the body of the concrete and no coarse aggregate is exposed. The surface shall then be floated with a wooden float to a smooth and uniform surface.
- C. When the concrete has hardened sufficiently the surface shall be given a broom finish. The broom shall be an approved type. The strokes shall be square across the concrete from edge to edge with adjacent strokes overlapped. Strokes shall be made without tearing the concrete. The broomed finish shall produce regular corrugations not over 1/8 inch in depth.
- D. Concrete that is adjacent to forms and formed joints shall be edged with a suitable edging tool to the dimensions shown on the plans.
- E. Street names shall be placed in the first tangent section of curb with 4-inch letter stamps.

3.05 JOINTING

- A. CONTRACTION JOINTS - Transverse weakened-plane contraction joints shall be constructed at right angles to the curb line at intervals not exceeding 15 feet. Joint depth shall average at least 1/4 of the cross section of the concrete.
 1. Contraction joints may be sawed, hand-formed, or made by 1/8-inch-thick division plates in the formwork.

2. Sawing shall be done early after the concrete has set to prevent the formation of uncontrolled cracking.
 3. The joints may be hand-formed either by (1) using a narrow or triangular jointing tool or a thin metal blade to impress a plane of weakness into the plastic concrete, or (2) inserting 1/8-inch-thick steel strips into the plastic concrete temporarily. Steel strips shall be withdrawn before final finishing of the concrete.
 4. Where division plates are used to make contraction joints, the plates shall be removed after the concrete has set and while the forms are still in place.
- B. EXPANSION JOINTS - Expansion joints shall be constructed at right angles to the curb line at immovable structures and at points of curvature for short-radius curves.
1. Filler material for expansion joints shall be furnished in a single 3/4-inch-thick piece for the full depth and width of the joint.
 2. Expansion joints in a slip-formed curb or curb and gutter shall be constructed with an appropriate hand tool by raking or sawing through partially set concrete for the full depth and width of the section. The cut shall be only wide enough to permit a snug fit for the joint filler. After the filler is placed, open areas adjacent to the filler shall be filled with concrete and then troweled and edged.
 3. Alternately, an expansion joint may be installed by removing a short section of freshly extruded curb and gutter immediately, installing temporary holding forms, placing the expansion joint filler, and replacing and reconsolidating the concrete that was removed. Contaminated concrete shall be discarded.
- C. Construction joints may be either butt or expansion type joints.
- D. Curbs or combined curbs and gutters constructed adjacent to existing concrete shall have the same type of joints as in the existing concrete, with similar spacing; however, contraction joint spacing shall not exceed 15 feet.

3.06**PROTECTION**

- A. Contractor shall always have materials available to protect the surface of the plastic concrete against rain. These materials shall consist of waterproof paper or plastic sheeting. For slip-form construction, materials such as wood planks or forms to protect the edges shall also be required.
- B. When concrete is being placed in cold weather and the temperature may be expected to drop below 35°F, suitable protection shall be provided to keep the concrete from freezing until it is at least 72 hours old. Concrete injured by frost action shall be removed and replaced at Contractor's expense.

3.07**CURING**

- A. Curing shall be in accordance with Section 03370, CONCRETE CURING.

3.08 BACKFILLING

- A. After the concrete has set sufficiently, the spaces in front and back of curbs shall be backfilled with original material or as shown on the drawings to the required elevations.
- B. The backfill material shall be thoroughly compacted to a density equal to that of adjacent materials.

3.09 TOLERANCES

- A. The work shall be performed in a manner which results in a curb and gutter constructed to specified line and grade, uniform in appearance and structurally sound.
- B. Curb and gutter found with unsightly bulges, ridges, low spots in the gutter or other defects shall be removed and replaced at Contractor's expense if Engineer considers them to be irreparable.
- C. When checked with a 10-foot straightedge, grade shall not deviate more than 1/4 inch, and alignment shall not vary more than 1/2 inch.
- D. Final elevation shall not depart from plan elevation by more than 1/2 inch.

PART 4 METHOD OF MEASUREMENT AND BASIS OF PAYMENT

4.01 METHOD OF MEASUREMENT

- A. This item shall be measured along the flow line of the curb by the linear feet of concrete curbs and combined curb and gutter in place.

4.02 BASIS OF PAYMENT

- A. Payment shall constitute full compensation for all materials, curing of concrete, for all pre-molded mastic material for expansion joints, contraction joints, steel dowels and sleeves, and for the excavation and the placing and compaction of embankment under the curb, furnishing and placing of backfill and topsoil behind the curb, and for all equipment, tools and labor and for the performance of all work and incidentals necessary to complete the item.
- B. Payment will be made at the contract unit price bid multiplied by the number of linear feet constructed.

END OF SECTION

SECTION 02545 – BITUMINOUS MATERIALS

PART 1 GENERAL

1.01 SUMMARY

- A. These specifications include general requirements applicable to all types of bases or pavements that require the application of bituminous materials by spray or mix. Deviations from these general requirements will be indicated in the specific requirements for each type.

1.02 RELATED WORK

- A. Section 02511, Road Mix Bituminous Pavements
- B. Section 02512, Plant Mix Pavements
- C. Section 02550, Prime Coat
- D. Section 0255 1, Tack Coat
- E. Section 02552, Seal Coat

1.03 REFERENCES

- A. AASHTO M81: Cutback Asphalt (Rapid-Curing Type)
- B. AASHTO M82: Cutback Asphalt (Medium-Curing Type)
- C. AASHTO M140: Emulsified Asphalt
- D. AASHTO M208: Cationic Emulsified Asphalt
- E. AASHTO M226: Viscosity Graded Asphalt Cement
- F. AASHTO M320: Performance-Graded Asphalt Binder
- G. AASHTO R66: Standard Practice for Sampling Bituminous Materials
- H. AASHTO T301: Standard Method of Test for Elastic Recovery Test of Asphalt Materials by Means of a Ductilometer

1.04 SUBMITTALS

- A. Bituminous material may be conditionally accepted at the source based on test reports furnished by Contractor for each 40 tons or 10,000 gallons loaded.
- B. A sample of each load of Asphaltic Materials is to be obtained at the time of conveyance loading, and the Certificate of Compliance, together with this sample, shall be surrendered to Engineer on the project. Sampling shall be accomplished using methods described and outlined in AASHTO T40.

- C. Tank trucks delivering bituminous material to the project shall be equipped with a sampling cock on the discharge pipe.
- D. Bituminous materials used on the project which do not meet the specification requirements for the type and grade specified may, at the direction of Engineer:
 - 1. Be rejected and Contractor required to remove and replace all materials affected by the out-of-specification material at his expense;
 - 2. Be accepted and left in place and the contract price of the bituminous material deducted, or be accepted at a reduced unit price as directed by Engineer.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Bituminous materials shall meet all applicable requirements. No materials or products other than those designated in this Section will be added to bituminous material without the express permission of Engineer.

2.02 PERFORMANCE GRADED ASPHALT BINDER

- A. The grade(s) shown on the plans or otherwise specified shall conform to the current edition of the Wyoming Department of Transportation Standard Specifications for Road and Bridge Construction.

2.03 LIQUID CUTBACK ASPHALTS

- A. Liquid cutback asphalts shall conform to the requirements of AASHTO M81 and AASHTO M82. The spot test shall be negative for all grades when tested with naphtha xylene solvent using 15 percent xylene. The Saybolt-Furol viscosity alternate will not apply.

2.04 EMULSIFIED ASPHALTS

- A. Emulsified asphalts shall conform to the following requirements:
 - 1. Emulsified Asphalt (Anionic) AASHTO M140
 - 2. Emulsified Asphalt (Cationic) AASHTO M208
- B. The designation “h” added to any grade of Emulsified Asphalt requires the residue from distillation to have a penetration from 40 to 90.
- C. The following exceptions apply to grade CMS-2 only:
 - 1. Viscosity: Seconds Saybolt-Furol at 122°F 50 Min.-500 Max.
 - 2. Distillation: Percent Residue 60 Min.
 - 3. Distillation: Oil Distillate, by volume of emulsion - to be determined by independent laboratory from produced materials, not to exceed 20 percent.

- D. The letter “F” following the bituminous material type designation shall require a satisfactory anti-stripping agent be added to the material at the refinery.
- E. The presence of anti-tripping agents will be determined in accordance with the Wyoming Quick Bottle Test or other approved means.

PART 3 EXECUTION

3.01 PREPARATION

- A. The water used for the dilution shall be free of sediment and other deleterious matter.

3.02 APPLICATION

- A. The rate of emulsified asphalt used for fog seal or tack shown in the Contract Documents is the rate of Emulsified Asphalt as received from the refinery.
- B. The emulsified asphalt used for tack may be diluted in the field at a rate of 50 percent emulsified asphalt and 50 percent additional water.
- C. The emulsified asphalt used for fog seal may be diluted in the field at a rate of 33 percent emulsified asphalt and 67 percent additional water.
- D. Both the dilution water and the emulsion shall be heated to approximately 110°F prior to mixing, and this approximate temperature shall be maintained during the application. Dilution shall be made by introducing the water into the emulsified asphalt.
- E. Bituminous materials for the various types of applications shall be loaded and applied within the temperatures indicated in the following table:

Type and Grade of Material	Application – Spray		Mixing Temperature	
	°F	°C	°F	°C
RT 1, 2, & 3	60-130	16-54	60-130	16-54
RT 5 & 6	85-150	29-66	85-150	29-66
RT 7, 8, & 9	150-225	66-107	150-225	66-107
RT 10, 11, & 12	175-250	79-121	175-250	79-121
RTC70	100-180	38-82	90-140	32-60
250	160-220	71-104	140-175	60-79
800	175-250	79-121	170-210	77-99
3000	220-275	104-135	200-240	93-116
Mc30	90-180	32-82	60-120	16-49
70	120-200	49-93	95-140	35-60
250	160-220	71-104	140-200	60-93
800	175-250	79-121	175-240	79-116
3000	200-290	93-143	200-250	93-121
SC70	120-200	49-93	95-140	35-60
250	160-220	71-104	140-200	60-93
800	175-250	79-121	175-210	79-99
3000	200-290	93-143	200-250	93-121
SC70	120-200	49-93	95-140	35-60

250	160-220	71-104	140200	60-93
800	175-2580	79-121	175-210	79-99
3000	200-290	93-143	200-250	93-121

All emulsions 50-140 50-140
All penetration grades 350 max. As required to achieve
Viscosity of 75-150
Seconds Saybolt-Furol

F. The maximum loading temperature for asphalt cements shall be 350°F.

PART 4 METHOD OF MEASUREMENT AND BASIS OF PAYMENT

4.01 METHOD OF MEASUREMENT

- A. Bituminous material will be measured by the ton. When volumetric measurements are used to determine the amount of bituminous material furnished to the project, stored, or returned to the plant, the volume will be converted to weight by calculation of gallons per ton at 60°F.
- B. The weight of asphalt emulsions will include the weight of water specified to be mixed at the refinery as a part of the type of emulsified asphalt designated. Water added on the road or at the mixing plant will not be measured for payment as emulsified asphalt.

4.02 BASIS OF PAYMENT

- A. All work performed and measured as provided above will be paid for as provided in the respective sections for each type of bituminous materials specified.
- B. All water, labor, and equipment necessary to make the field dilution will not be measured for payment, but will be considered subsidiary to other pay items of the contract.

END OF SECTION

SECTION 02550 — PRIME COAT

PART 1 GENERAL

1.01 SUMMARY

- A. This work shall consist of preparing and treating an existing surface with bituminous material and blotter material, if required, in accordance with these specifications and in reasonably close conformity with the lines shown on the plans or established by Engineer.

1.02 RELATED WORK

- A. Section 02190, Aggregates
- B. Section 02511, Road Mix Bituminous Pavements
- C. Section 02512, Plant Mix Pavements
- D. Section 02545, Bituminous Materials
- E. Section 02553, Bituminous Surface Treatment

1.03 REFERENCES

- A. AASHTO M81: Cutback Asphalt (Rapid-Curing Type)
- B. AASHTO M82: Cutback Asphalt (Medium Curing Type)
- C. AASHTO M140: Emulsified Asphalt
- D. AASHTO M208: Cationic Emulsified Asphalt
- E. AASHTO M226: Viscosity Graded Asphalt Cement
- F. AASHTO R66: Standard Practice for Sampling Asphalt Materials

PART 2 PRODUCTS

2.01 MATERIALS

- A. Bituminous materials - The type of bituminous material will be specified in the contract, and the grade will be designated by Engineer. The bituminous material shall meet the applicable requirements of Section 02545, BITUMINOUS MATERIALS.
- B. Blotter Material - Blotter material shall meet the requirements of Section 02190, AGGREGATES, Subsection 2.11. The material will be accepted based on periodic samples taken at the latest practicable point prior to incorporation into the work.

PART 3 EXECUTION

3.01 PREPARATION

- A. The surface to be primed shall be shaped to the required grade and section, shall be free from all ruts, corrugations segregated material, or other irregularities, and shall be uniformly compacted.
- B. Delays in priming shall require reprocessing or reshaping to provide a smooth, compacted surface.

3.02 APPLICATION

- A. Weather Limitation - Prime coat shall be applied only when the surface on which the material is to be applied is dry and when the atmospheric temperature is above 50°F.
- B. Equipment - Contractor shall provide equipment for heating and applying the bituminous material and for applying blotter material.
- C. The quantities, rate of application, and areas to be treated shall be approved before application of the prime coat. Application temperatures shall be in accordance with Section 02545, BITUMINOUS MATERIALS.
- D. Excess bituminous material shall be squeegeed from the surface. Skipped areas or deficiencies shall be corrected.
- E. After the application of the prime coat, if the bituminous material fails to penetrate and the roadway must be used by traffic, blotter material shall be spread in the amounts required to absorb any excess bituminous material.
- F. Bituminous material shall be applied to the width of the section to be primed by means of a pressure distributor in a uniform, continuous spread. When traffic is maintained through construction, not more than one-half of the width of the section shall be treated in one application. Care shall be taken that the application of bituminous material at the junctions of spreads is not in excess of the specified amount.

3.03 PROTECTION

- A. Traffic control shall be in accordance with US DOT FHWA Manual on Uniform Traffic Control Devices unless otherwise specified by Engineer in the Special Provisions.
- B. When traffic is maintained, one-way traffic shall be permitted on the untreated portion of the roadbed. As soon as the bituminous material has been absorbed by the surface and will not pick up, traffic shall be transferred to the treated portion and the remaining width of the section shall be primed.

PART 4 METHOD OF MEASUREMENT AND BASIS OF PAYMENT

4.01 METHOD OF MEASUREMENT

- A. Bituminous material will be measured by the ton. Blotter material will be measured by the ton.

4.02 BASIS OF PAYMENT

- A. The accepted quantities of prime coat will be paid for at the contract price per ton for bituminous material and per ton for blotter material complete in place. No payment for haul of blotter material will be made. Payment will be made under:

PAY ITEM	PAY UNIT
Asphalt Cement	Ton
Liquid Asphalt (Prime)	Ton
Emulsified Asphalt (Prime)	Ton
Blotter Material	Ton

END OF SECTION

SECTION 02551 — TACK COAT

PART 1 GENERAL

1.01 SUMMARY

- A. This work shall consist of preparing and treating an existing bituminous or concrete surface with bituminous material in accordance with these specifications and in reasonably close conformity with the lines shown on the plans or established by Engineer.

1.02 RELATED WORK

- A. Section 02545, Bituminous Materials
- B. Section 02511, Road Mix Bituminous Pavements
- C. Section 02512, Plant Mix Pavements

1.03 REFERENCES

- A. AASHTO M81: Cutback Asphalt (Rapid-Curing Type)
- B. AASHTO M82: Cutback Asphalt (Medium-Curing Type)
- C. AASHTO M140: Emulsified Asphalt
- D. AASHTO M208: Cationic Emulsified Asphalt
- E. AASHTO M226: Viscosity Graded Asphalt Cement
- F. AASHTO R66: Standard Practice for Sampling Asphalt Materials

PART 2 PRODUCTS

2.01 MATERIALS

- A. Unless otherwise specified, the type of bituminous material used for tack may be, at the option of Contractor, any emulsion or performance-graded asphalt binder that provides for adequate bond between the pavement layers and does not result in track out, agglomerations, or other objectionable occurrences.
- B. The bituminous material shall meet the applicable requirements of Section 02545, BITUMINOUS MATERIALS.

PART 3 EXECUTION

3.01 PREPARATION

- A. The existing surface shall be patched and cleaned and shall be free of irregularities to provide a reasonably smooth and uniform surface to receive the treatment. Unstable corrugated areas shall be removed and replaced with suitable patching materials. Payment for the patching will be made at the contract unit price for the various items

used unless a reconditioning item is included in the contract. The edges of existing pavements which are to be adjacent to new pavement shall be cleaned to permit the adhesion of bituminous materials.

3.02 APPLICATION

A. APPLICATION OF BITUMINOUS MATERIAL

1. The bituminous material shall be uniformly applied with a pressure distributor.
2. The tack coat shall be applied in such manner as to offer the least inconvenience to traffic and to permit one-way traffic without pickup or tracking of the bituminous material.
3. Tack coat shall not be applied to a wet surface or during unsuitable weather conditions. The quantity, rate of application, and areas to be treated shall be approved by Engineer prior to application. In no case shall the application rate result in less than 0.03 gallons of residual asphalt per square yard on smooth (unground) pavement surfaces or less than 0.05 gallons of residual asphalt per square yard on cold milled surfaces. Application temperatures shall be in accordance with Section 02545, BITUMINOUS MATERIALS, Subsection 3.02, or in accordance with the manufacturer's recommendations.

B. EQUIPMENT

1. Contractor shall provide equipment for heating and applying the bituminous material.

PART 4 METHOD OF MEASUREMENT AND BASIS OF PAYMENT

4.01 METHOD OF MEASUREMENT

- A. The bituminous material for tack coat will be measured by the ton of original (undiluted) emulsion or Performance-Graded Asphalt Binder.

4.02 BASIS OF PAYMENT

- A. The accepted quantities of tack coat will be paid for at the contract unit price per ton for bituminous material complete in place. Payment will be made under:

PAY ITEM	PAY UNIT
Asphalt Cement	Ton
Liquid Asphalt (Prime)	Ton
Emulsified Asphalt (Prime)	Ton
Blotter Material	Ton

END OF SECTION

SECTION 02552 — SEAL COAT

PART 1 GENERAL

1.01 SUMMARY

- A. This work shall consist of an application of bituminous material followed by an application of cover coat material in accordance with these specifications and in reasonably close conformity with the lines shown on the plans or established by Engineer.

1.02 RELATED WORK

- A. Section 02190, Aggregates
- B. Section 02511, Road Mix Bituminous Pavements
- C. Section 02512, Plant Mix Pavements
- D. Section 02545, Bituminous Materials

1.03 REFERENCES

- A. AASHTO M81: Cutback Asphalt (Rapid-Curing Type)
- B. AASHTO M82: Cutback Asphalt (Medium-Curing Type)
- C. AASHTO M140: Emulsified Asphalt
- D. AASHTO M208: Cationic Emulsified Asphalt
- E. AASHTO M226: Viscosity Graded Asphalt Cement
- F. AASHTO R66: Standard Practice for Sampling Asphalt Materials

1.04 DEFINITIONS

- A. Plain seal shall consist of the application of bituminous material and a sand cover coat, where required.

PART 2 PRODUCTS

2.01 MATERIALS

- A. BITUMINOUS MATERIAL
 - 1. The type of bituminous material will be specified in the contract, and the grade will be designated by Engineer.
 - 2. The bituminous material shall meet the applicable requirements of Section 02545, BITUMINOUS MATERIALS.

B. COVER COAT MATERIAL

1. Cover coat material shall meet the requirements of Section 02190, AGGREGATES, Subsection 2.10, for the type specified. The material will be accepted based on periodic samples taken at the latest practicable point prior to incorporation into the work.
2. Stockpiled material shall meet the requirements of Section 02190, AGGREGATES, Subsection 3.01.

PART 3 EXECUTION

3.01 PREPARATION

- A. Seal coating operations shall not be started until the surface is thoroughly compacted.
- B. Bituminous material shall not be spread until the surface has been cleaned as required and the section to be sealed has been approved.

3.02 APPLICATION

A. WEATHER LIMITATIONS

1. Seal coat shall be applied only when the surface on which the material is to be applied is dry and when the atmospheric temperature is above 40°F.
2. Plain seal shall be applied when the surface is dry and the weather conditions are suitable for the proper application of the bituminous material specified.

B. EQUIPMENT - The following equipment or its equivalent shall be required:

1. Equipment for heating and applying bituminous material.
2. A rotary power broom.
3. A pneumatic-tired roller which shall be self-propelled, the gross load of which shall be adjustable to apply 200 to 350 pounds per rolling width as directed. Tire pressure or contact pressure may be specified for pneumatic-tired rollers. Pneumatic-tired rollers shall be operated at a speed that ensures aggregate embedment and coverage.
4. A self-propelled aggregate spreader of approved design supported by at least 4 wheels equipped with pneumatic tires on 2 axles. The aggregate spreader shall be equipped with a means of applying the larger cover coat material to the surface ahead of the smaller cover coat material and with positive controls so that the required amount of material will be deposited uniformly over the full width of the bituminous material. Other types of aggregate spreaders may be used provided they accomplish equivalent results and are approved.

C. BITUMINOUS MATERIALS

1. Bituminous material shall be applied by means of a pressure distributor in a uniform, continuous spread over the section to be treated and within the temperature range specified. The quantity of bituminous material to be used per square yard shall be as directed. If the texture of the surface is such that bituminous material penetrates too rapidly, a preliminary application of from 0.05 to 0.10 gallon per square yard of surface may be required.
2. The distributor shall be moving forward at proper application speed at the time the spray bar is opened. Any skipped areas or deficiencies shall be corrected. Junctions of spreads shall be carefully made to assure a smooth riding surface.
3. The spreads of bituminous material shall not be more than 6 inches wider than the width covered by the cover coat material from the spreading device. Under no circumstances shall operations proceed in such manner that bituminous material will be allowed to chill, set up, dry, or otherwise impair retention of the cover coat.
4. The distributor, when not spreading, shall be parked so that the spray bar or mechanism will not drip bituminous materials on the surface of the traveled way.

D. COVER COAT MATERIAL

1. Immediately following the application of the bituminous material, cover coat material shall be spread in quantities as designated. Spreading shall be accomplished in such a manner that the tires of the trucks or aggregate spreader at no time contact the uncovered and newly applied bituminous material.
2. The cover coat material shall be moistened with water when required to eliminate or reduce the dust coating of the aggregate. Moistening shall be done the day before the use of aggregates.
3. Immediately after the cover coat material is spread, any deficient areas shall be covered by additional material. Pneumatic-tire rolling shall begin immediately and shall be continued until three complete coverages are obtained. Pneumatic-tire rolling shall be completed the same day the bituminous material and cover coat materials are applied.
4. After the application and rolling of the cover coat material, the surface where specified shall be lightly broomed or otherwise maintained as directed for a period of 4 days, or as directed. Maintenance of the surface shall include the distribution of cover coat material over the surface to absorb any free bituminous material and cover any area deficient in cover coat materials. The maintenance shall be conducted so as not to displace embedded materials. Excess material shall be swept from the entire surface by means of rotary brooms. The surface shall be swept at the time determined by Engineer.

3.03 PROTECTION

- A. Areas where bituminous materials would be picked up, or the seal otherwise damaged by traffic, shall be covered by a protective coat of sand. When confined to small areas, the sand coat may be applied by hand spreading and smoothed by sweeping.

PART 4 METHOD OF MEASUREMENT AND BASIS OF PAYMENT

4.01 METHOD OF MEASUREMENT

- A. Bituminous material will be measured by the ton and cover coat material will be measured by the ton.

4.02 BASIS OF PAYMENT

- A. The accepted quantities of seal coat will be paid for at the contract price per ton for bituminous material and per ton for cover coat material complete in place including haul. Payment will be made under:

PAY ITEM	PAY UNIT
Asphalt Cement	Ton
Liquid Asphalt (Prime)	Ton
Emulsified Asphalt (Prime)	Ton
Cover Coat Material	Ton

END OF SECTION

SECTION 02553 — BITUMINOUS SURFACE TREATMENT

PART 1 GENERAL

1.01 SUMMARY

- A. This work shall consist of the construction of a single- or multiple-course bituminous surface treatment in accordance with these specifications and in reasonably close conformity with the lines shown on the Drawings or as established by Engineer.
- B. The bituminous surface treatment may consist of the application of one or more seal coats or may consist of a prime coat followed by one or more seal coats as specified in the Contract Documents.

1.02 RELATED WORK

- A. Section 02190, Aggregates
- B. Section 02545, Bituminous Materials
- C. Section 02550, Prime Coat
- D. Section 02552, Seal Coat

1.03 REFERENCES

- A. AASHTO M81: Cutback Asphalt (Rapid-Curing Type)
- B. AASHTO M82: Cutback Asphalt (Medium-Curing Type)
- C. AASHTO M140: Emulsified Asphalt
- D. AASHTO M208: Cationic Emulsified Asphalt
- E. AASHTO M226: Viscosity Graded Asphalt Cement
- F. AASHTO R66: Standard Practice for Sampling Asphalt Materials

PART 2 PRODUCTS

2.01 MATERIALS

- A. BITUMINOUS MATERIAL
 - 1. The types of bituminous material will be specified in the Contract Documents. The grade will be designated by Engineer.
 - 2. The bituminous material shall meet the applicable requirements of Section 02545, BITUMINOUS MATERIALS.
- B. AGGREGATES
 - 1. Aggregates and blotter material shall meet the requirements of Section 02190, AGGREGATES, Subsection 2.11, for the sizes specified. The material will be

accepted based on periodic samples taken at the latest practicable point prior to incorporation into the work.

2. Stockpiled material shall meet the requirements of Section 02190, AGGREGATES, Subsection 3.01.

PART 3 EXECUTION

3.01 PREPARATION

- A. See requirements of related Sections.

3.02 APPLICATION

A. PRIME COAT

1. The prime coat, when specified, shall be applied in accordance with the requirements of Section 02550, PRIME COAT.
2. A curing period of 3 days is required between the application of the prime coat and the next application of bituminous material unless otherwise specified by Engineer in the Special Provisions.

B. SEAL COAT

1. Each seal coat shall be applied in accordance with Section 02552, SEAL COAT. If successive seal coats are to be applied, the previous seal coat shall be maintained and permitted to cure for a period of 3 days unless otherwise specified by Engineer in the Special Provisions.

3.03 PROTECTION

- A. During the period between the application of the prime coat and the seal coat, the primed surface shall be kept in repair. All holes, ravels, and areas deficient in prime shall be patched and repaired with bituminous treated materials, by penetration methods or other approved procedures.

PART 4 METHOD OF MEASUREMENT AND BASIS OF PAYMENT

4.01 METHOD OF MEASUREMENT

- A. Bituminous material, cover coat material and blotter material will be measured by the ton.

4.02 BASIS OF PAYMENT

- A. The accepted quantities of bituminous surface treatment will be paid for at the contract unit price per ton for bituminous material complete in place. No payment for haul of blotter material will be made. Payment will be made under:

PAY ITEM

PAY UNIT

Liquid Asphalt (Bit. Surf. Trtmt.)	Ton
Emulsified Asphalt (Bit. Surf. Trtmt.)	Ton
Liquid Asphalt (Prime)	Ton
Cover Coat Material	Ton
Blotter Material	Ton

END OF SECTION

SECTION 02570 — ADJUSTING STREET FIXTURES

PART 1 GENERAL

1.01 SUMMARY

- A. This item shall consist of locating and adjusting to grade existing manholes, cleanouts, inlets, water valve boxes or services and fire hydrants as shown on the plans and as required in the Special Provisions.

PART 2 PRODUCTS

2.01 MATERIALS

- A. All material such as concrete brick and mortar shall meet specifications as required in the section on the particular material involved, or if the material is not covered in these specifications, the material used for adjusting shall be equal, and comparable to that in the existing structure. If extensions for water valve boxes or services and fire hydrants are required beyond the length found to exist, they shall be comparable to that in the existing structure.

PART 3 EXECUTION

3.01 METHOD OF CONSTRUCTION

- A. All existing manholes, inlets, cleanouts and water valve boxes or services shall be brought to grade by either lowering or raising as required in accordance with the details shown on the Drawings. Where lowering of manholes, cleanouts or inlets is required, care shall be used in removing the top portion of the masonry or pipe. Before the ring and cover is replaced, the top of the masonry on the manhole, cleanout or inlet must be true to line and grade.
- B. Water valve boxes and services shall be excavated and exposed in order to determine whether height adjustment can be made without substituting a longer section. Water valve boxes and services shall be adjusted laterally so the valve stem can be operated by the extension. Water services shall be adjusted by raising or lowering the curb key stop or extension box as specified in the Special Provisions or as shown in the Drawings.
- C. Manholes, cleanouts and water valve boxes shall be adjusted to final grade before the seal coat is applied. Preliminary adjustment may be required to allow placing of base courses and paving over the manholes, cleanout or water valve.
- D. Backfill shall be in conformance with Section 02210: PORTLAND CEMENT CONCRETE. There may be adjustments required in the horizontal location of some existing fire hydrants. At the time of construction staking, any hydrants that require horizontal adjustment will be located by Engineer and the adjusted location will be staked by Engineer as shown on the Drawings.

- E. There may be minor adjustment required as dimensioned on the plans in the height of some existing fire hydrants to insure that they are at a reasonable height behind the back of curb. At the time of construction staking, any hydrants that require vertical adjustment will be located by Engineer and the adjusted height will be staked by Engineer.
- F. Before final acceptance, all manholes, cleanouts, inlets and water valve boxes or services shall be cleaned, and water valve boxes or services and fire hydrants shall be operational.

PART 4 METHOD OF MEASUREMENT AND BASIS OF PAYMENT

4.01 METHOD OF MEASUREMENT

- A. Existing manholes, cleanouts, inlets, water valve boxes and water services to adjust. These items shall be measured by the number of existing facilities adjusted, complete in place.
- B. LOCATION ADJUSTMENT FOR EXISTING FIRE HYDRANTS. This item shall be measured by the number of existing fire hydrants adjusted horizontally, complete in place.
- C. VERTICAL ADJUSTMENT FOR EXISTING FIRE HYDRANTS. This item shall be measured by the number of existing fire hydrants adjusted vertically, complete in place.

4.02 BASIS OF PAYMENT

- A. Payment shall be made at the contract unit price bid for each item multiplied by the respective number of units adjusted.

Payment will be made under:
Adjust Sewer Manholes – Per Each
Adjust Sewer Cleanouts – Per Each
Adjust Storm Drain Inlets – Per Each
Adjust Water Valve Boxes – Per Each
Adjust Water Services – Per Each
Horizontal Adjust Fire Hydrant – Per Each
Vertically Adjust Fire Hydrant – Per Each
- B. Payment shall constitute full compensation for all materials, excavation, backfill, compaction, cleaning, labor, tools and incidentals necessary to complete each item.

END OF SECTION

SECTION 02645 — FIRE HYDRANTS

PART 1 GENERAL

1.01 SUMMARY

- A. This section consists of installation of fire hydrants together with related appurtenances, complete.

1.02 REFERENCES

- A. AWWA C502: Dry-Barrel Fire Hydrants

PART 2 PRODUCTS

2.01 MATERIALS

A. DRY-BARREL FIRE HYDRANTS

1. Fire hydrants shall conform to standard for dry-barrel fire hydrants, AWWA C502, and modifications herein specified.
2. Hydrants shall be furnished with 5-inch minimum valve openings, one pumper connection and two 2-1/2 hose connections. Hose nozzle threads, pumper nozzle threads, operating nut, and opening direction shall match existing hydrant.
3. Hydrants shall be of the "Compression" or "Toggle Joint" type with safety flange and safety stem coupling above the ground line so that they can be repaired without shutting off the water. Hydrants shall be of the dry top design with two or more "O" rings sealing the water from the operating mechanism. The portion of the hydrant above the ground line shall be painted in accordance with Owner's standards. Hydrants shall be furnished for 6-foot cover unless specified otherwise in the Special Provisions. Hydrants installed behind curbs typically require an additional 6 inches height. Contractor should take this into consideration.
4. Hydrants shall not include drain openings or drain rock if the hydrant shoe is below the local water table, as noted on the Drawings. Hydrants without weep holes shall have markings to identify that the barrel needs to be pumped after normal operations in accordance with the National Fire Protection Association (NFPA) 25 standard.

PART 3 EXECUTION

3.01 INSTALLATION

- A. All hydrants shall stand plumb with the pumper nozzle facing the street. Hydrant shall be set with the ground line at the location indicated by the hydrant manufacturer. Hydrants shall be installed such that they have drainage away from them at the surface. Proper boot lengths shall be used to avoid hydrants installed in holes or depression.

- B. Drainage shall be provided at the base of the hydrant by placing clean gravel under and around the base of the hydrant. Sufficient gravel shall be used to provide a minimum of 1 foot on all sides from the base of the hydrant to the point at least 6 inches above the drain opening. Hydrant shall be braced against unexcavated earth at the end of the trench with concrete backing as detailed on the plans. Hydrants shall be furnished with auxiliary gate valves as specified above. Hydrant installation shall be in accordance with Standard Drawing No. 02645-01 or as revised in the Special Revisions and/or Drawings.

PART 4 METHOD OF MEASUREMENT AND BASIS OF PAYMENT

4.01 METHOD OF MEASUREMENT

- A. Measurement of fire hydrants shall be made by numerical count each.

4.02 BASIS OF PAYMENT

- A. Payment for this item will be made at the contract unit price bid each; which price shall include furnishing and installing the fire hydrant and auxiliary gate valve and box, all additional excavation, backfill, and special compaction required for the installation, thrust and anchor blocking, drain gravel, and all other work necessary or incidental for completion of the item.

END OF SECTION

SECTION 02665 — WATER DISTRIBUTION AND TRANSMISSION SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

- A. This section consists of construction of Water Mains, including fittings, water valves, water services, water service piping, tapping the main, corporation stops, curb stops, and other appurtenances normally used for water supply and distribution systems, including furnishing and installing pipe, water valves, and fittings, construction of thrust blocking, testing, cleaning and disinfection of mains and other related work.

1.02 REFERENCES

- A. AWWA C104/A21.4-16: Cement-Mortar Lining for Ductile Iron Pipe and Fittings
- B. AWWA C105/A21.5-18: Polyethylene Encasement for Ductile-Iron Pipe Systems
- C. AWWA C110/A21.10-821: Ductile-Iron and Gray-Iron Fittings, 3" through 48", for Water and Other Liquids
- D. AWWA C111/A21.11-17: Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
- E. AWWA C151/A21.51-17: Ductile-Iron Pipe, Centrifugally Cast
- F. AWWA C500: Metal-Seated Gate Valves for Water Supply Service
- G. AWWA C504: Rubber-Seated Butterfly Valves
- H. AWWA C509: Resilient-Seated Gate Valves for Water Supply Service
- I. AWWA C550: Protective Interior Coatings for Valves and Hydrants
- J. AWWA C600: Installation of Ductile-Iron Mains and Their Appurtenances
- K. AWWA C605: Underground Installation of Polyvinyl Chloride (PVC) and Molecularly Oriented Polyvinyl Chloride (OPVC) Pressure Pipe and Fittings
- L. AWWA C900: Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 In. Through 60 In.
- M. AWWA C901: Polyethylene (PE) Pressure Pipe and Tubing, ¾ In. Through 3 In., for Water Service
- N. ANSI/AWWA C906: Polyethylene (PE) Pressure Pipe and Fittings, 4 In. through 65 In., for Waterworks
- O. AWWA C907: Injection-Molded Polyvinyl Chloride (PVC) Pressure Fittings, 4 In. Through 12 In.
- P. AWWA C909: Molecular Oriented Polyvinyl Chloride (PVCO) Pressure Pipe, 4 In. and Larger

- Q. AWWA C950: Fiberglass Pressure Pipe
- R. AWWA M23: PVC – Design and Installation
- S. AWWA M55: PE Pipe - Design and Installation
- T. ASTM B88: Seamless Copper Water Tube
- U. ASTM C272: Standard Test Method for Water Absorption of Core Materials for Sandwich Constructions
- V. ASTM C518: Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus
- W. ASTM D1621: Standard Test Method for Compressive Properties of Rigid Cellular Plastics
- X. ASTM D2241: Poly(Vinyl Chloride) (PVC) Pressure-Related Pipe (SDR Series)

1.03

QUALITY ASSURANCE

- A. When required by Engineer, Contractor shall furnish certification by the manufacturer of the pipe to be furnished on this project, certifying that the pipe and fittings comply with the applicable specifications. Required certification shall accompany each delivery of material.
- B. All pipe shall be clearly marked with type, class and/or thickness as applicable. Lettering shall be legible and permanent under normal conditions of handling and storage.

PART 2

PRODUCTS

2.01

MATERIALS

- A. PIPE
 - 1. Pipe used in water main construction shall be as called out in the Special Provisions and shall be in accordance with the following specifications:
 - 2. DUCTILE IRON PIPE
 - a. Ductile iron pipe shall conform to the provisions of AWWA C151. Wall thickness shall be as shown in the Special Provisions.
 - b. Pipe joints shall be mechanical joint or “Push-On” joints conforming to AWWA C111.
 - c. The interior of the pipe shall have a cement mortar lining conforming to the requirements of AWWA C104. The outside surface of pipe designed for underground service shall receive a bituminous coating approximately 1-mil thick.

- d. When polyethylene encasement is required, the requirements of AWWA C105 shall be met.

3. POLYVINYL CHLORIDE (PVC) PRESSURE PIPE

- a. PVC pipe for the water mains shall meet the requirements of AWWA C900 made to ductile iron O.D.'s for "Push-On" joints. Pipe joints shall be with an elastomeric gasket or joint. Pipe class shall be as specified in the Special Provisions.

4. Polyethylene (PE) Pressure Pipe and Fittings shall meet the requirements of AWWA C906.

5. Molecular Oriented Polyvinyl Chloride (PVCO) Pressure Pipe for water mains shall meet the requirements of AWWA C909.

6. CASING PIPE

- a. Pipe used to case waterline - sewer line crossings shall be PVC DR-26 water pipe or PVC DR-35 sewer pipe with a minimum inside diameter of 1.25 times outside diameter of carrier pipe.
- b. Casing pipe shall be sealed at both ends with materials to prevent the migration of water into the annular space.

B. FITTINGS AND COUPLINGS

- 1. Cast iron or ductile iron fittings used for water mains shall be Class 250 conforming to AWWA C110. Joints for Ductile Iron and PVC Pipe shall be mechanical joint or "Push-On" joints conforming to AWWA C111. The interior of the fitting shall have a cement mortar lining conforming to AWWA C104. The outside surface of the fitting shall receive a bituminous coating approximately 1-mil thick. Couplings for making connections to existing pipelines and fire hydrants shall be mechanical-joint connecting pieces and mechanical-joint sleeves, or an approved equal.
- 2. PVC fittings may be used for water mains 4 inches through 8 inches in diameter and shall conform to AWWA C907 or an approved equal.

C. AIR RELIEF VALVES, BLOW OFFS, FLUSHING HYDRANTS

- 1. These shall be of the same material as the main installation and shall meet pressure and flow requirements equal to or exceeding the main installation or as required by the manufacturer.

D. GATE VALVES

- 1. Gate valves shall be iron body, bronze mounted, double disc gate valves with non-rising stems with design, construction and pressure rating conforming to AWWA C500, with modifications specified herein.

2. Stem seals shall be double "O" ring seals designed so that the seal above the stem collar can be replaced with the valve under pressure in full-open position.
3. Gate valves for underground installation shall have a two-inch square wrench nut for key operation. All valves shall open counterclockwise unless indicated otherwise in the special provisions.

E. BUTTERFLY VALVES

1. Butterfly valves for use in the water distribution system shall be Class 150 rubber seated, tight closing butterfly valves conforming to AWWA C504. Butterfly valves shall be furnished with mechanical joint ends and lubricated screw type operators designed for underground service.
2. Rubber valve seats shall be replaceable without disassembling the valve and shall not be interrupted by the shafting. Rubber seats may be retained on the disc edge by stainless steel clamping in lieu of bonding to the valve body. Shaft packing shall be of the self-adjusting permanent type.
3. Operators for underground service shall be permanently lubricated screw-type operators, totally enclosed and of watertight construction. Overload protection shall be incorporated into the operator allowing the application of 450 foot-pounds input torque at full-open and full-closed positions without damage to the operator or valve. A 2-inch square wrench nut and valve box shall be provided for operating the valve. Valves shall open counter clockwise unless indicated otherwise in the Special Provisions.
4. Certification of performance, leakage and hydrostatic tests as described in AWWA C504 shall be furnished when required by Engineer. Valves shall be the product of a manufacturer having a minimum of 5 years' experience in the manufacture of water works and distribution valves.

F. RESILIENT SEATED GATE VALVES

1. Resilient Seated Gate Valves shall be iron body, with non-rising stems with design, construction, and pressure rating conforming to AWWA C509, standard for Resilient Seated Gate Valves with modifications specified herein.
2. Waterway shall be smooth and shall have no depressions or cavities in seat area where foreign material can lodge and prevent closure or sealing.
3. Stem seals shall be double "O" ring seals designed so that the seal above the stem collar can be replaced with the valve under pressure in full-open position.
4. Resilient Seated Gate Valves for underground installation shall have 2-inch square wrench nut for key operation. All valves shall open counterclockwise unless indicated otherwise in the special provisions.
5. The Resilient Seated Gate Valves' interior parts and surfaces shall be coated in accordance with AWWA C550.

G. VALVE BOXES

1. Valve boxes shall be cast iron, 5-1/4-inch-diameter adjustable valve boxes. Valve boxes shall be of the screw type and of sufficient length for the pipe bury as specified. The cast iron cover of the valve box shall have an arrow indicating the direction of opening and the word "Water" stamped thereon.

H. WATER SERVICE PIPE

1. Pipe used in water service line construction shall be copper, or polyethylene service pipe as called out in the Special Provisions and shall conform to the following specifications:
 - a. Copper Service Pipe shall be type K soft, conforming to ASTM B88.
 - b. Polyethylene (PE) Service Pipe shall be pressure tubing conforming to the requirements of AWWA C901. Tubing shall be PE4710, Class 250 with a SDR of 9.0.

I. CORPORATION STOPS

1. Corporation stops shall be brass corporation stops with inlet and outlet as specified in the Special Provisions and/or on the Drawings.

J. COMPRESSION CONNECTIONS

1. Ends of polyethylene tubing inserted in compression connections should be fitted with insert reinforcement.

K. SERVICE CLAMPS

1. Service clamps, where required, shall be flat double strap, bronze metal or other noncorrosive material, with Neoprene gaskets and corporation stop threads. Service clamps for PVC shall provide full support around the circumference of the pipe, and have a bearing area of sufficient width along the axis of the pipe so that the pipe will not be distorted when tightened.

L. CURB STOPS

1. Curb stops shall be bronze inverted key stops or ball-valve type as specified on the Drawings and/or in the Special Provisions. Curb boxes shall be likewise specified.

M. PIPE INSULATION

1. Pipe insulation shall be high density, extruded polystyrene foam insulation board for buried service.
2. The 5-year aged R Value per inch shall be 5 when tested at 75°F mean temperature in accordance with ASTM C518.
3. Minimum compressive strength of 25 psi when tested in accordance with ASTM D1621.

4. Maximum water absorption of 0.1% by volume when tested in accordance with ASTM C272.

PART 3 EXECUTION

3.01 CONSTRUCTION

A. GENERAL

1. Pipe shall be installed in accordance with the manufacturer's recommendations for installing the type of pipe used unless otherwise noted in the Special Provisions. Contractor shall provide all tools and equipment including any special tools designed for installing each particular type of pipe used.
2. Service pipe shall be of the size or sizes designated in the Contract Documents. Service lines shall be considered 2-inch size and under. Service lines over 2-inch size shall be considered as water mains and shall be as specified under the applicable sections.

B. DEWATERING OF TRENCH

1. Where water is encountered in the trench, it shall be removed during pipe-laying operations and the trench so maintained until the ends of the pipe are sealed and provisions are made to prevent floating of the pipe.

C. RESPONSIBILITY FOR MATERIAL

1. Contractor shall be responsible for all material furnished and shall replace all such material found defective in manufacture or damaged in handling after delivery by the manufacturer. This shall include the furnishing of all materials and labor required for the placement of installed material discovered damaged or defective prior to the final acceptance of the work, or during the guarantee period.
2. Contractor shall be responsible for the safe and proper storage of material furnished and accepted by Contractor, and intended for the work, until it has been incorporated in the completed project. The interior of all pipe and other accessories shall be kept free from dirt and foreign matter at all times.

D. HANDLING OF PIPE

1. All pipe furnished by Contractor shall be delivered and distributed at the site by Contractor. Pipe, fittings, specials, valves and accessories shall be loaded and unloaded by lifting with hoists or skidding so as to avoid shock or damage. Under no circumstances shall such materials be dropped. Pipe handled on skidways shall not be skidded or rolled against pipe already on the ground.
2. In distributing the material at the site of the work, each piece shall be unloaded opposite or near the place where it is to be laid in the trench.

3. Pipe shall be so handled that the coating and lining will not be damaged. If, however, any part of the coating or lining is damaged, the repair shall be made by Contractor at Contractor's expense in a manner satisfactory to Engineer.

E. LAYING OF PIPE

1. Before installation, the pipe and pipe coating shall be inspected for defects. Any damage to pipe coatings shall be repaired as recommended by the pipe manufacturer before laying the pipe.
2. All pipe shall be laid and maintained to the required lines and grades with fittings and valves at the required locations.
3. Grade and alignment on ungraded streets will be given from hubs set parallel to the line of the pipe, and on graded streets the grade and alignment shall be taken from established points on the existing curbs or sidewalks, when directed by Engineer. Trenches for the pipe shall be opened in accordance with the lines and grades given or to the standard depth of cover provided on the Drawings and/or in the Special Provisions. Contractor shall transfer lines and grades to the pipe from marks set by Engineer or from existing concrete curbs or sidewalks as an incidental part of his work.
4. Wherever obstructions not shown on the plans are encountered during the progress of the work and interfere to such an extent that an alteration in the plan is required, Engineer shall have the authority to change the plans and order a deviation from the line and grade or arrange with the owners of the structures for the removal, relocation and reconstruction of the obstructions. If the change in plans results in a change in the amount of work by Contractor, such altered work shall be done on the basis of payment to Contractor for extra work or credit to Owner for less work.
5. Proper implements, tools and facilities satisfactory to Engineer shall be provided and used by Contractor for the safe and convenient prosecution of the work. All pipe, fittings and valves shall be carefully lowered into the trench piece by piece by means of a derrick, ropes or other suitable tools or equipment, in such a manner as to prevent damage to pipe materials and protective coatings and linings. Under no circumstances shall materials be dropped or dumped into the trench.
6. Every precaution shall be taken to prevent foreign material from entering the pipe while it is being placed in the line. During laying operations, no debris, tools, clothing or other materials shall be placed in the pipe. At times when pipe laying is not in progress, the open ends of the pipe shall be closed by a watertight plug or other means approved by Engineer.
7. Long radius curves, either horizontal or vertical, may be laid with standard pipe by deflections at the joints, as allowed by the pipe manufacturer's installation instructions. If the pipe is shown curved on the plans and no special fittings are

shown, Contractor can assume that the curves can be made by deflection of the joints with standard lengths of pipe. If shorter lengths are required, the plan will indicate maximum lengths that can be used.

8. Where field conditions require deflection or curves not anticipated by the plans, Engineer will determine the fittings to be used and additional payment will be made for specified fittings. No additional payment will be made for laying pipe on curves as shown on the plans, nor for field changes involving standard lengths of pipe deflected at the joints. Upon approval of Engineer, Contractor may choose to install additional or substitute fittings during completion of the work, at no additional cost to the project.
9. Maximum deflections at pipe joints for various types of pipe shall not exceed the applicable material and joint specifications of AWWA nor shall they exceed the recommendations of the pipe manufacturer. When rubber-gasketed pipe is laid on a curve, the pipe shall be jointed in a straight alignment and then deflected to the curved alignment. Trenches shall be made wide on curves for this purpose.
10. Reaction or thrust blocking shall be applied at all tees, plugs, caps and at bends deflecting 11-1/4 degrees or more, or movement shall be prevented by attaching suitable metal rods or straps as approved by Engineer. Reaction blocking shall be concrete having a compressive strength of not less than 2000 pounds per square inch at 28 days. Blocking shall be placed between solid ground and the fitting to be anchored; the area of bearing on the pipe and on the ground shall be as shown on Standard Drawing 02665-03 or as revised in the Special Revisions and/or Drawings. The blocking shall be so placed that the pipe and fitting joints will be accessible for repair.
11. The cutting of pipe for inserting valves, fittings or closure pieces shall be done in a neat and workmanlike manner without damage to the pipe or coating and so as to leave a smooth end at right angles to the axis of the pipe. The flame cutting of pipe by means of an oxyacetylene torch shall not be allowed.

F. SEPARATION OF WATER MAINS AND SEWERS

1. PARALLEL INSTALLATION

- a. NORMAL CONDITIONS - Water mains shall be laid at least 10 feet horizontally from any sanitary sewer, storm sewer, or manhole, whenever possible. The distance shall be measured edge-to-edge.
- b. UNUSUAL CONDITIONS - When local conditions prevent a horizontal separation of 10 feet, a water main may be laid closer to a sanitary sewer, storm sewer, or manhole, provided that:
 - 1) The bottom of the water main is at least 18 inches above the top of the sanitary or storm sewer; or

- 2) The trench backfill consists of cement treated backfill in accordance with Section 02225, TRENCH BACKFILL. Cement treated backfill must bear on undisturbed soil.
- 3) Where 18 inches vertical separation as noted above cannot be obtained, the sewer shall be:
 - a) Constructed of materials and with joints that are equivalent to water main standards of construction and tested for water tightness by sewer line methods per Section 02700, SANITARY SEWER SYSTEMS; or
 - b) Placed in a separate casing pipe.

2. CROSSING

- a. NORMAL CONDITIONS - Water mains crossing sanitary sewers, sanitary sewer service lines, or storm sewers shall be laid above to provide a vertical separation of at least 18 inches whenever possible. The distance shall be measured from the top of the sewer pipe to the bottom of the water pipe.
- b. UNUSUAL CONDITIONS - When local conditions prevent a vertical separation of at least 18 inches as noted above, the following construction shall be used:
 - 1) The sanitary sewer or storm sewer shall be constructed of materials and with joints that are equivalent to water main standards of construction and shall be tested for water tightness by sewer line methods as per Section 02700, SANITARY SEWER SYSTEMS; or
 - 2) The sanitary sewer, storm sewer or water main shall be placed in a separate casing pipe; or
 - 3) The length of the sewer line constructed to water main standards, or the casing pipe shall extend a minimum of 9 feet each side of the crossing.
 - 4) Water mains passing under sewer lines shall in addition to the above requirements, be protected by providing adequate structural support for the sewer line. Soil structural support shall consist of cement treated backfill in accordance with Section 02225, TRENCH BACKFILL. Cement treated backfill must bear on undisturbed soil.

3.02

SETTING VALVES AND VALVE BOXES

- A. Gate valves shall be set and jointed to the pipe in the manner specified for pipe laying and jointing. Valves shall be set with operating nut vertical. Valve boxes shall be centered and plumb over the operating nut and shall be set so that no shock or stress will be transmitted to the valve.
- B. Resilient Seated Gate Valves shall be set and jointed to the pipe in the manner specified for pipe laying and jointing. Valves shall be set with operating nut vertical.

Valve boxes shall be centered and plumb over the operating nut and shall be set so that no shock or stress will be transmitted to the valve.

- C. Valve boxes shall be centered and plumb over the operating nut of the valve. Tops of valve boxes shall be set flush with the ground surface or street surfacing unless otherwise directed by Engineer.

3.03 SERVICE CONNECTIONS

A. GENERAL

1. Contractor shall provide all work and materials for the complete service line installation, including trench excavation and backfill; making the water main tap; furnishing and installing the corporation stop, curb stop and box, service clamp where necessary, and service line with fittings as required to make the connections to the stops. The service line adjacent to the water main shall be bent slightly into a figure "S" to avoid a rigid connection. All services shall have a minimum of 6 feet of cover or as shown in the Drawings.
2. Contractor shall furnish and install the service pipe from the main to the property line with a curb stop and extension service box installed at the property line.
3. Installation of water service lines shall be in accordance with Standard Drawing No. 02665-01 or as revised in the Special Revisions and/or Drawings.

B. SEPARATIONS

1. The service connection shall be installed such that a minimum horizontal separation, measured center to center, of 10 feet is maintained.

C. TAPPING

1. Actual tapping of the water mains shall be made by Contractor unless otherwise specified in the Special Provisions and/or Drawings. Contractor shall be responsible for notifying Owner and Engineer in advance of the time that a tap will be made, and coordinating all activities in this regard with Owner and Engineer.
2. Tapping directly into the barrel of PVC and AC pipe will be done using service clamps unless otherwise specified in the Special Provisions and/or on the Drawings.

3.04 VALVE THRUST BLOCKS

- A. All valves to be installed which call for thrust blocks and anchor rods shall be installed in accordance with and as detailed on Standard Drawing No. 02665-03 or as revised in the Special Revisions and/or Drawings.

3.05 PIPE JOINTING

A. RUBBER GASKET "PUSH-ON" JOINTS

1. Jointing of pipe and fittings with a rubber gasket "push-on" joint shall be as recommended by the manufacturer. The rubber gasket and gasket seat inside the bell shall be wiped clean with a cloth. A thin film of lubricant, furnished with the pipe, shall be applied to the inside surface of the gasket. The plain end of the adjoining pipe shall be wiped clean and inserted into the bell a sufficient distance to make contact with the gasket. The plain end shall then be forced "home" by the use of a crow bar, fork tool, or jack assembly. The use of an excavator bucket or other equipment not specifically approved by the manufacturer and Engineer to assemble the pipe is prohibited. If a stop line exists on the plain end of a pipe, the plain end shall not be pushed into the bell of the adjoining pipe past the stop line.

B. MECHANICAL JOINTS

1. The inside of the bell and the outside of the spigot of the mechanical joint fittings shall be brushed thoroughly with a wire brush to remove all loose rust or other foreign material just prior to assembly. The cleaned surfaces shall be brushed with soapy water just prior to slipping the gasket over the spigot end and into the bell.
2. The spigot end of the pipe or fitting shall be accurately centered in the bell before jointing is begun. After the gasket is in place the gland shall be brought up toward the pipe flange evenly, maintaining approximately the same distance between the gland and the face of the flange at all points around the socket. Bolts shall be partially tightened alternately around the socket maintaining approximately equal tension until the final tension is reached.
3. The normal range of bolt torques to be applied to the cast iron bolts in the joints shall be as follows:

BOLT SIZE (inch)	RANGE OF TORQUE (ft. lb.)
5/8	40-60
3/4	60 -90
1	70-100
1-1/4	90-120

The above torque loads may be applied with torque measuring or indicating wrenches, or they may be applied using regular socket wrenches, and checked to torque wrenches.

4. If effective sealing is not attained at the maximum torque indicated above, the joint shall be disassembled and reassembled after thorough cleaning. Overstressing of bolts to compensate for poor installation practice will not be permitted.

C. CONNECTIONS TO EXISTING MAINS

1. All connections to water mains in use shall be made by Contractor unless otherwise provided in the Special Provisions. Contractor shall furnish the special,

as shown on the plans, and all other material required. He shall make all necessary excavations to assure gradual transition between the new and existing water main, and he shall perform all necessary backfilling.

2. Where the connection of new work to old requires interruption of service and notification of customers affected, the superintendent of the utility, Engineer and Contractor shall mutually agree upon a date for connections which will allow ample time to assemble labor and materials, and to notify all customers affected.

3.06 INSTALLATION OF SHALLOW WATERLINES

A. SHALLOW WATER LINES

1. Installation of shallow water lines shall only be permitted as shown by the contract documents.
2. All installation procedures shall be reviewed by Engineer prior to execution of the work.
3. Pipe insulation shall be installed where called for on the plans or required by Engineer. Insulation shall be 2 feet wide by 2 inches thick rigid insulation centered over the pipe. Where shown on the plans or drawings, insulation may be extended vertically on both sides of the pipe.
4. Compact pipe bedding material to top of pipe bell, provide smooth compacted surface for insulation board, center insulation board on pipe, place 4 to 6 inches of pipe bedding material over insulation board.

3.07 HYDROSTATIC TESTING AND DISINFECTION

- A. Pipe and appurtenances shall be pressure tested in accordance with the appropriate AWWA Standard depending on pipe material.
- B. Pipe and appurtenances shall be disinfected in accordance with AWWA C651

PART 4 METHOD OF MEASUREMENT AND BASIS OF PAYMENT

4.01 METHOD OF MEASUREMENT

A. WATER MAINS

1. Measurement of water mains shall be made in lineal feet along the centerline of pipe through all valves, fittings, and appurtenances.

B. FITTINGS

1. Measurement of water main fittings will be by numerical count of the various types and sizes listed in the Proposal.

C. WATER VALVES

1. Measurement of water valves shall be made by numerical count of the sizes and types of valves listed in the Proposal.

D. THRUST BLOCKS

1. Measurement of valve thrust blocks shall be made by numerical count of each size type listed in the bid schedule actually installed.

E. WATER SERVICE LINES

1. This item shall be measured by numerical count of water services of the various sizes listed in the Proposal.
2. No measurement and payment will be made for Trench Excavation and Backfill for water service lines and the cost of this work shall be included in the price bid for service lines.

F. PIPE INSULATION

1. Measurement of pipe insulation shall be made in linear feet along the centerline of the installed insulation.

4.02

BASIS OF PAYMENT

A. WATER MAIN

1. Payment for water main will be made at the contract unit price bid per lineal foot of the various sizes called for, which price shall include trench excavation, backfill, furnishing and installing pipe; furnishing and placing bedding; cleaning, testing, and disinfecting the water main and all other work necessary or incidental for completion of the item.

B. FITTINGS

1. Payment for fittings will be made at the contract unit price bid for each fitting, which price shall include furnishing and installing the fittings as required, thrust blocking and any other work necessary or incidental for completion of the item.

C. WATER VALVES

1. Payment for water valves will be made at the contract unit price bid each; which price shall include furnishing and installing the valve and valve box, all additional excavation, backfill, and special compaction required for the installation, and all other work necessary or incidental for completion of the item.

D. THRUST BLOCKS

1. Payment for this item will be made at the contract unit price bid each; which price shall include all additional excavation, installation (including all bolts, strapping and concrete), backfill and compaction.

E. WATER SERVICE LINES

1. Payment for Water Service Connections will be made at the contract unit price bid each, which price shall include furnishing and installing the water service line from the main to the property line; tapping the main; furnishing and installing all fittings, corporation stops, curb stops and boxes, tapping saddles if required; all trench excavation, backfill, pipe bedding, shoring, and dewatering; cleanup and all other work necessary or incidental for completion of the item. Payment for these items shall be full compensation for providing all materials, tools, labor and equipment necessary to complete the item and all incidental work related thereto, whether specifically mentioned herein or not.

F. PIPE INSULATION

1. Payment for pipe insulation will be made at the contract unit price per linear feet of insulation, which price shall constitute full compensation for furnishing all labor, equipment, material, transportation, and incidentals necessary to install the pipe insulation as described herein and shown on the drawings.

END OF SECTION

SECTION 02700 — SANITARY SEWER SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

- A. This section consists of construction of sanitary sewer mains, including manholes, service lines, and other appurtenant structures, complete.

1.02 REFERENCES

- A. Where the reference is made to an ASTM, ANSI or AASHTO designation, it shall be the latest revision at the time of call for bids, except as noted on the Drawings or in the Special Provisions.
- B. ASTM A746: Ductile Iron Gravity Sewer Pipe
- C. ASTM C14: Nonreinforced Concrete Sewer, Storm Drain, and Culvert Pipe
- D. ASTM C76: Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe
- E. ASTM C425: Compression Joints for Vitrified Clay Pipe and Fittings
- F. ASTM C443: Joints for Concrete Pipe and Manholes, Using Rubber Gaskets
- G. ASTM C478: Circular Precast Reinforced Concrete Manhole Sections
- H. ASTM C700: Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated
- I. ASTM C828: Low-Pressure Air Test of Vitrified Clay Pipe Lines
- J. ASTM C924: Testing Concrete Pipe Sewer Lines by Low-Pressure Air Test Method (withdrawn)
- K. ASTM C1103: Joint Acceptance Testing of Installed Precast Concrete Pipe Sewer Lines
- L. ASTM D1784: Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
- M. ASTM D2680: Acrylonitrile-Butadiene-Styrene (ABS) and Poly(Vinyl Chloride) (PVC) Composite Sewer Piping
- N. ASTM D3034: Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings
- O. ASTM F679: Poly(Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings
- P. ASTM F1417: Installation Acceptance of Plastic Non-pressure Sewer Lines Using Low-Pressure Air
- Q. AASHTO M199: Precast Reinforced Concrete Manhole Sections

1.03**QUALITY ASSURANCE**

- A. Sewer pipe and fittings furnished under this contract shall be as called out in the Contract Documents. Wye or tee branches shall be of the same material and design as the sewer pipe used. Pipe strength classifications shall be as listed in the Contract Documents.
- B. When required by Engineer, Contractor shall furnish certification by the manufacturer of the pipe to be furnished on this Project, certifying that the pipe and fittings comply with the applicable specifications. Required certification shall accompany each delivery of material.
- C. All pipe shall be clearly marked with type, class and/or, thickness as applicable. Lettering shall be legible and permanent under normal conditions of handling and storage.
- D. Type of joint, class, thickness designation, castings, lining, marking, testing, etc., shall be as specified.

PART 2**PRODUCTS****2.01****MATERIALS**

A. POLYVINYL CHLORIDE (PVC) PIPE

- 1. PVC Sewer Pipe shall be produced by a continuous extrusion process, employing a prime grade of un-plasticized polyvinyl chloride. The grade used shall be highly resistant to hydrogen sulfide, sulfuric acid, gasoline, oil, detergents and other chemicals commonly found in sewage and industrial wastes. The material shall conform to the requirements of ASTM D1784. The pipe shall have self-extinguishing flammability characteristics.
- 2. Pipe and fittings shall conform to ASTM D3034 or ASTM F679 for sizes over 15 inches in diameter. PVC pipe shall have a minimum Standard Dimension Ratio (SDR) of 35.
- 3. Nominal laying lengths shall be not less than 12.5 feet, except shorter lengths may be used adjacent to manholes, lamp holes or other appurtenances. Each length of pipe shall be marked with size, SDR, "Sewer Pipe" and Code Number.
- 4. Pipe Jointing
 - a. Each length of pipe shall be provided with a bell designed so that a watertight joint will be obtained when jointing the bell and spigot with a rubber ring.
 - b. The rubber gasket joint for PVC pipe and fittings shall consist of a rubber gasket which is compressed between the outer surface of the spigot and the inner surface of a retaining groove in the bell. The joint shall be completely sealed by the gasket so that the assembly will remain watertight under all conditions of service, including movements resulting from expansion,

contraction, settlement and deformation of the pipe. The rubber ring joint assembly shall be made in strict accordance with the manufacturer's recommendations.

5. Wye or tee fittings for connecting service lines shall be of the same material, construction and joint design as the main sewer pipe.

B. CONCRETE PIPE

1. Concrete sewer pipe shall conform to ASTM C14, and/or ASTM C76, except as noted hereafter. Strength classifications for C14 and/or C76 specification pipe shall be as listed in the Contract Documents.
2. The maximum absorption allowed shall be 8 percent, as stated in the above ASTM Specification. For pipe sizes smaller than 12 inches in diameter the proportion of portland cement in the concrete mixture shall not be less than 6.5 U.S. standard bags (94 pounds per cubic yard) of concrete, and the water cement ratio shall not exceed 6 gallons per sack of cement.
3. The referenced ASTM specifications list permissible variations in pipe dimensions. They shall be strictly adhered to, and the uniformity of barrel thickness shall be such that a constant flow area without projections exists across joints.
4. Wye or tee fittings for connecting service lines shall be of the same material, construction and joint design as the main sewer pipe.
5. Joints for concrete pipe shall be made using flexible watertight, rubber-type gaskets conforming to ASTM C443.
6. The pipe supplier shall furnish Engineer with certified test results from an independent testing laboratory on the following: (1) crushing strength using the 3-edge bearing method, (2) absorption, and (3) hydrostatic performance. Test results shall be furnished for each pipe size supplied for this project and the number of tests performed shall be in accordance with ASTM C14 and/or C76, or a minimum of 2 percent of the number of pipe supplied, whichever is greater. Cost of these tests shall be borne by the pipe supplier and/or Contractor.

C. ACRYLONITRILE BUTADIENE STYRENE (ABS) COMPOSITE SEWER PIPE

1. ABS pipe shall conform in all aspects to ASTM D2680.
2. Tee or wye fittings for connecting service lines shall be of the same material, construction and joint design as the main sewer pipe. Fittings shall be shop fabricated or molded from materials listed in ASTM D2680 and shall be of equivalent quality to those described.
3. All field joints shall be chemically welded. Primer, then cement shall be applied liberally to the outside of the spigot end and the inside of the coupling immediately prior to stabbing the pipe together. Pipe spigot end shall be supplied with home marks to assure proper jointing.

4. When other than full lengths of pipe are laid, the “cut end” of the pipe must be sealed with a sealant provided by the manufacturer of the pipe.

D. VITRIFIED CLAY PIPE (VCP)

1. VCP pipe shall conform to ASTM C700 and shall be “Extra-Strength”.
2. Wye or tee fittings for connecting service lines shall be of the same material, construction and joint design as the main sewer pipe or a method approved by Engineer.
3. All field joints shall meet the manufacturer’s requirements for the pipe being used and conform to the latest revision of ASTM C425.
4. In addition to any deficiencies covered by ASTM C700, clay pipe which has any of the following visual defects will not be accepted:
 - a. Improperly formed pipe such that pipe intended to be straight has an ordinate, measured from the concave side of the pipe, exceeding 1/16 inch per foot of length.
 - b. Pipe which is sufficiently out-of-round to prohibit proper jointing.
 - c. Improperly formed bell and spigot ends.
 - d. Fractured, cracked, chipped, or otherwise sufficiently damaged pipe which will result in an improperly constructed pipeline.
 - e. Pipe that has been damaged during shipment or handling, even if previously approved before shipment.

E. DUCTILE IRON PIPE

1. Ductile iron pipe shall conform in all aspects to the latest revisions of ASTM A746.
2. Wye or tee fittings for connecting service lines shall be of the same material, construction and joint design as the main sewer pipe or a method approved by Engineer.
3. All field joints shall meet the manufacturers’ requirement for the brand of pipe being used.

F. CASING PIPE

1. Pipe used to case waterline crossings shall be SDR-26 PVC water pipe or SDR-35 PVC sewer pipe with a minimum diameter of 1.25 times the outside diameter of the carrier pipe.
2. Acceptance of the pipe at point of delivery will not relieve Contractor of full responsibility for any defects in material or workmanship of the completed pipeline.

3. Casing pipe shall be sealed to prevent the entry or exiting of water to or from the carrier pipe. Casing pipe spacers shall be utilized to center the pipe in the casing pipe.

G. MANHOLES

1. All manholes shall be designed to withstand AASHTO HS20 (MS18) loading.
2. Manholes shall be constructed of precast concrete rings with frames and covers and steps in accordance with AASHTO M199 and as shown in Standard Drawings No. 02700-01 and 02 or as revised in the Special Revisions and/or Drawings.
3. Rings and covers shall be in accordance with Owner's standards. Covers shall be non-ventilated type unless otherwise noted in the Special Provisions and/or on Drawings.
4. Adjusting rings may be used for adjusting the manhole top elevation to coincide with existing ground elevations, except the total height of adjusting rings used per manhole shall not exceed 12 inches. Adjusting rings shall be reinforced with the same percentage of steel as the riser and top.
5. Precast Concrete rings for manholes shall conform to ASTM C478.
6. When required, noncorrosive steps of rubber encased steel, aluminum, or nylon shall be used. Steps shall withstand vertical loads of 400 pounds and pull-out resistance of 1,000 pounds.
7. Concrete bases shall be precast or poured in the field on undisturbed earth. Concrete shall conform to Section 03304, PORTLAND CEMENT CONCRETE.

H. GRAVITY SEWER SERVICE MATERIALS

1. Type of joint, class, thickness designation, castings, lining, marking, testing, etc., shall be as required in the Special Provisions and/or on Drawings.

PART 3 EXECUTION

3.01 PIPE INSTALLATION

A. RESPONSIBILITY FOR MATERIAL

1. Contractor shall be responsible for all material furnished by them and shall replace at their own expense all such material found defective in manufacture or damaged in handling after delivery by the manufacturer. This shall include furnishing all material and labor required for the replacement of installed material discovered defective prior to final acceptance of the work or during the guarantee period.
2. Contractor shall be responsible for the safe storage of material intended for the work until it has been incorporated in the completed project.

B. HANDLING OF PIPE

1. All pipe furnished by Contractor shall be delivered and distributed at the site by Contractor. Pipe, fittings, and accessories shall be loaded and unloaded by lifting with hoists or skidding so as to avoid shock or damage. Under no circumstances shall materials be dropped. Pipe handled on skidways shall not be skidded or rolled against pipe already on the ground.
2. In distributing the material at the site of the work, each piece shall be unloaded opposite or near the place where it is to be laid in the trench. The interior of all pipe and other accessories shall be kept free from dirt and foreign matter at all times.
3. Pipe shall be handled so that no coating or lining will be damaged. If, however, any part of the coating or lining is damaged, the repair shall be made by Contractor at their expense in a manner satisfactory to Engineer.

C. LAYING PIPE

1. All pipe shall be laid and maintained to the required lines and grades with fittings, tees and manholes at the required locations.
2. Contractor shall use good workmanship. All pipe shall be properly jointed home, using wood cushion and protective devices in accordance with manufacturer's recommendations.
3. Proper tools and equipment satisfactory to Engineer shall be used by Contractor for the safe and convenient prosecution of the work. All pipe and fittings shall be carefully lowered into the trench in such a manner as to prevent damage to pipe materials and protective coatings and linings. Under no circumstances shall materials be dropped or dumped into the trench.
4. Every precaution shall be taken to prevent foreign material from entering the pipe while it is being installed. At times when pipe laying is not in progress, the open ends of pipe shall be closed by a plug or other means approved by Engineer. Contractor shall clean and remove all sand, gravel, concrete and cement grout that has entered the lines in the process of construction.
5. The bottom of the trench shall be shaped to fit the bottom quadrant of the pipe, with holes for couplings just large enough to permit their assembly.

D. JOINTS

1. The spigot and bell ends of the pipe and couplings shall be thoroughly cleaned before joint assembly. Jointing of the pipe shall be in strict accordance with the recommendations of the manufacturer of the pipe and fittings. The correct position of the rubber gaskets and proper assembly of the pipe shall be checked by means of a feeler gauge prior to backfilling of the trench. On larger diameter pipe, which will provide room for workmen inside, all joints shall be visually

inspected and gauged inside for proper position of the gasket and joint gap tolerances.

2. The sewers shall be installed within 1/4 inch for grade and shall not be off more than 1/2 inch for alignment. Engineer shall specify joint deflection tolerance where acceptable.

E. TOLERANCES

The sewers shall be installed within ¼ inch for grade and shall not be off more than 1/2 inch for alignment. Engineer shall specify joint deflection tolerance where acceptable.

F. SEPARATION OF WATER MAINS AND SEWERS

1. PARALLEL INSTALLATION

- a. NORMAL CONDITIONS - Sanitary sewer mains and manholes shall be laid at least 10 feet horizontally from any water main whenever possible. The distance shall be measured edge-to-edge.
- b. UNUSUAL CONDITIONS - When local conditions prevent a horizontal separation of 10 feet as noted above, a sewer main may be laid closer to a water main, provided that:
 - 1) The top of the sewer main is at least 18 inches below the bottom of the water main;
 - 2) Where 18 inches vertical separation as noted above cannot be obtained, the sewer main shall be:
 - a) constructed of materials and with joints that are equivalent to water main standards of construction, and tested to assure watertightness prior to backfilling; or
 - b) placed in a separate casing pipe; or
 - c) the trench backfill consists of cement treated backfill in accordance with Section 02225, TRENCH BACKFILL. Cement treated backfill must bear on undisturbed soil.

2. CROSSING

- a. NORMAL CONDITIONS - Sewers crossing water mains shall be laid below the water mains to provide a vertical separation of at least 18 inches, whenever possible. The distance shall be measured between the bottom of the water main and the top of the sewer.
- b. UNUSUAL CONDITIONS - When local conditions prevent a vertical separation of at least 18 inches as noted above, the following construction shall be used:

- 1) The sewer or water main shall be placed in a separate casing pipe; or
- 2) The sewer line shall be constructed of materials and with joints that are equivalent to water main standards of construction and tested to assure water tightness prior to backfilling;
- 3) The length of the sewer line constructed to water main standards or the casing pipe shall extend a minimum of 9 feet each side of the crossing.
- 4) Water mains passing under sewer lines shall in addition be protected by providing adequate structural support for the sewer line. Soil structural support shall consist of cement treated backfill in accordance with Section 02225. Cement treated backfill must bear on undisturbed soil.

3.02 MANHOLE INSTALLATION

- A. Manholes shall be constructed to the general dimensions shown. Invert channels shall be smooth and semicircular in shape conforming to the inside of the adjacent sewer section. Changes in direction of flow shall be made with a smooth curve of as large radius as the size of the manhole will permit. Changes in size and grade of the channels shall be made gradually and evenly. The invert channels may be formed directly in the concrete of the manhole base or may be half-pipe laid in concrete. The floor of the manhole outside the channel shall be smooth and shall slope toward the channel not less than 1 centimeter per meter, or more than 2 centimeter per meter.
- B. Free drop inside the manhole shall not exceed 2 feet measured from the invert of the inlet pipe to the invert of the outlet pipe. Where the drop exceeds 2 feet, drop manholes shall be constructed as shown on the typical manhole detail.
- C. All connections between wall sections shall be joined with "Kent Seal" manufactured by K.T. Snyder Company, "Con Seal" or approved equal, in such a manner to make the manhole watertight.
- D. Manhole construction shall not be greater than one manhole distance behind sewer line construction unless otherwise approved by Engineer.
- E. Pipe to manhole connections shall be resilient connectors which satisfy ASTM C 923.

3.03 SERVICE LINE INSTALLATION

- A. GENERAL
 1. Service lines shall be constructed in accordance with Standard Drawing No. 02700-05 or as revised in the Special Revisions and/or Drawings. The service line shall be installed to the property line. The end of the service line shall be plugged with an approved stopper or plug. Grouting of plugs will not be permitted.
 2. Wye or tee fittings shall be installed in the mainline sewer for connection of service lines. Service lines shall not protrude into the sewer. Wye or tee fittings shall be of the same material and design and of the same specifications of the

sewer main pipe. Jointing of service pipe to wye or tee branches of main line pipe other than PVC, shall be accomplished with special joint adapters manufactured specifically for jointing the two different types of pipe.

B. CROSSING

1. **NORMAL CONDITIONS** - Sanitary sewer service lines crossing water mains shall be laid to provide a vertical separation of at least 18 inches whenever possible. The distance shall be measured from the top of the lower pipe to the bottom of the upper pipe.
2. **UNUSUAL CONDITIONS** - When local conditions prevent a vertical separation of at least 18 inches as noted above, the sanitary sewer service line shall be placed in a separate casing pipe, said casing pipe shall extend a minimum of 10 feet each side of center of the crossing.

C. EXTENDING SEWER SERVICES INTO PRIVATE PROPERTY

1. Unless otherwise provided by local sewer ordinances, the property owners will be permitted to extend sewer services onto their property and connect fixtures thereto, as soon as the main sewer construction has progressed past the point of side sewer construction and leakage tests have been satisfactorily completed, provided the use of the connections will not interfere with the completion of the other parts of the contract work and provided the extension is approved by Engineer. Such sewer service connections shall be allowed only after final inspection and acceptance of main sewer.

D. END PIPE MARKER

The end of newly installed sewer service lines shall be marked by Contractor at the property line by a post 5 feet long buried in the ground a distance of 3 feet, in addition to a 1/2 inch diameter reinforcing bar, 18 inches in length, buried vertically 2 inches below the ground surface.

3.04

TESTING

A. LIGHT TEST

After the trench has been backfilled and compacted as specified in Section 02225, TRENCH BACKFILL a light test shall be made between manholes to check alignment and grade for displacement of pipe. Except for curved alignments shown on the Drawings, the completed pipeline shall be such that a true circle of light can be seen from one manhole to the next. If alignment or grade is other than specified and displacement of pipe is found, Contractor shall remedy such defects at their own expense.

B. T.V. INSPECTION

1. Owner may at their option require any or all sewer, sanitary or storm, to be inspected by the use of a television camera before final acceptance. The costs

incurred in making the initial inspection shall be borne by Owner unless otherwise noted in the Special Provisions.

2. Contractor shall bear all costs incurred in correcting any deficiencies found during television inspection including the cost of any additional television inspection that may be required by Owner to verify the correction of said deficiency.
3. Contractor shall be responsible for all costs incurred in any television inspection performed solely for the benefit of Contractor.

C. LEAKAGE TEST

1. New sewer line will not be finally accepted until leakage tests have been made to assure Engineer that pipe laying and jointing are satisfactory.

a. Water Test

- 1) Where groundwater is a minimum of 2 feet above the sewer line, tests shall be made by sealing off the section of lines between manholes and measuring the infiltration by collecting or pumping the discharge into barrels or other approved methods. Tests shall be continued over a period of at least 4 hours for each section tested. Sufficient time shall be allowed to soak lines and manholes in advance of performing tests.

- 2) When groundwater is not above the pipe, testing shall be as follows:

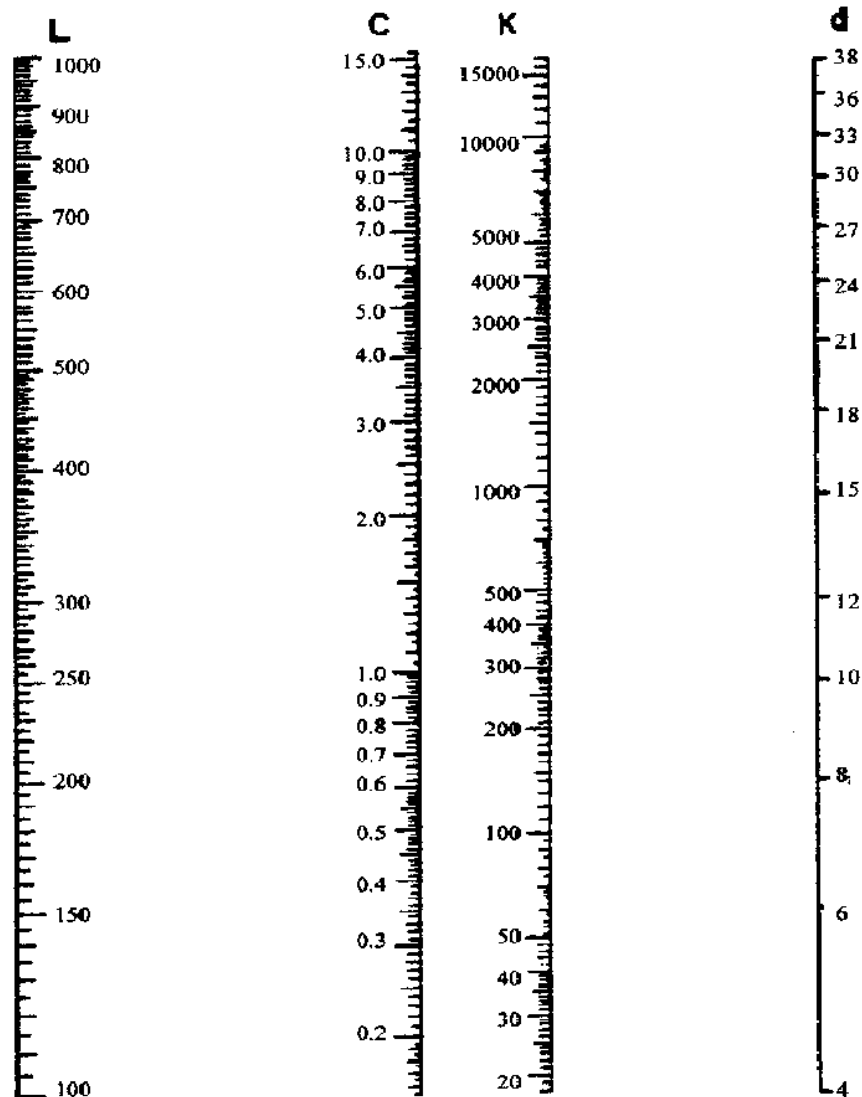
- a) On flat slopes where the depth over the centerline of the pipe in the lower manhole of the section being tested will be not more than 10 feet, the upper manhole shall be filled to a depth of 2 feet over the top of the pipe and the lower manhole blocked. When the above conditions cannot be met, Engineer may order Contractor to test the line in sections between manholes. The leakage shall be measured by checking the drop in water level in the manhole over a period of 4 hours.

- b) The maximum allowable infiltration or exfiltration, including manholes, shall not exceed 200 gallons per day per mile of sewer, per inch of pipe diameter. This does not preclude the fact that obvious and concentrated leaks, such as open joints, pinched gaskets, cracked barrels or bells, etc., will not be allowed. Contractor shall make repairs on concentrated leaks, and as necessary to reduce infiltration or exfiltration leakage below the specified rate, and at their own expense.

b. Air Test (Alternate)

- 1) As an alternate method to water testing, Contractor may utilize low pressure air as a means of testing the sewer mains. The test procedure shall be as described below:

- a) Plug both ends of the pipe under test with airtight plugs and brace adequately to prevent slippage and blowout. One plug shall have an inlet tap or other provision for connecting an air hose.
 - b) The air supply hose, connected between the air compressor and the plug, shall have a throttling valve, an air bleed valve, and a high pressure shut-off valve for control. The low pressure side of the throttling valve shall have a tee for a monitoring pressure gauge, protected by a gauge cock. This cock is kept closed except when the pressure loss is being timed.
 - c) If the pipeline is submerged under groundwater, the backpressure, caused by the water head, is measured and added to the standard test pressures to compensate for the groundwater effect on the air test.
 - d) Air shall be applied slowly to the pipeline until the pressure reaches 4.0 psig. The air supply shall then be throttled so that the internal pressure is maintained between 4.0 and 3.5 psig for at least 2 minutes. During this time the plugs shall be checked with soap solution to detect any plug leakage.
 - e) When the pressure reaches exactly 3.5 psig, a stop watch is started and the time recorded for the pressure to drop to 2.5 psig. The minimum time allowed for this pressure drop shall be computed based on an air loss rate of 2.0 cfm or an air loss rate of 0.0030 cfm per square foot of inner pipe surface under test, whichever rate gives the least time for the pressure drop. Should the time of the pressure drop between 3.5 and 2.5 psig be less than the allowable specified time, Contractor shall make the necessary leakage repairs and repeat the air test.
- 2) Table 1 on the following page provides a Nomograph which may be used to compute testing times for air testing. Air tests shall conform to ASTM C828 for clay pipe, ASTM C 924 (C 1214) or ASTM C 1103 (joint acceptance) for concrete pipe (withdrawn 2013), and ASTM F 1417 for plastic pipe.
2. Manhole joints shall be checked for leakage by means of water testing as specified above.



The nomograph shown on this page may be used to compute the specification time even if several different pipe diameters are included in one test. Draw a straight line connecting the diameter on the 'd' scale with the corresponding length of pipe of that diameter under test on the 'L' scale. Each line will cross the 'K' and 'C' scales. The corresponding values of 'K' and 'C' for each diameter - length combination under test are read and recorded. All the 'K' values are totaled, as are the 'C' values. Total 'K' governs if the total of 'C' is less than 1.0 in which case, total 'K' value equals the time in seconds that the pipeline under test should take before the pressure falls from 3.5 to 2.5 psig. If total 'C' is greater than 1.0, total 'K' is divided by total 'C' to obtain the specification time in seconds.

D. DEFLECTION TESTING

After the pipe has been laid and 30 days after the final backfill placed, all flexible pipe systems shall be tested for deflection in the presence of Engineer. This test shall consist of pulling a mandrel (Go-No Go Device) through the pipe. The maximum deflection allowable shall not exceed 5 percent of the pipe's internal diameter for final inspection. Contractor shall conduct the test and shall furnish all necessary test

equipment and labor. All pipe sections failing the test shall be removed and replaced at Contractor's expense.

E. NUMBER OF TESTS

A sufficient number of leakage tests shall be performed to assure Engineer that materials and workmanship are acceptable. Defective joints shall be repaired only by use of approved jointing material which is flexible when set and that has a permanent bond to the pipe. Pipe having cracked or broken barrels shall be replaced. The length of sewer line tested per test shall not exceed 800 feet.

F. MATERIALS AND EQUIPMENT FOR TESTING

Except as noted in Paragraph B, all labor, equipment, and materials (including water) necessary for making the tests of sewer lines shall be furnished by Contractor.

- G.** All tests, except deflection testing as specified under Paragraph D, shall be made after backfill is completed, but prior to any surface restoration or street surfacing. Contractor shall be responsible for finding and repairing all breaks and leaks revealed by the tests.

PART 4 METHOD OF MEASUREMENT AND BASIS PAYMENT

4.01 METHOD OF MEASUREMENT

A. SEWER MAIN

1. Measurement of sewer mains shall be made in lineal feet of the various sizes and classes, along the centerline of pipe from center to center of manholes.

B. MANHOLES

1. Measurement of manholes shall be made by numerical count each.

C. SERVICE LINES

1. Measurement will be along the pipe from the tee or wye of the main sewer through tees, wyes and other fittings to the street margin or right-of-way margin. Measurement will be to the nearest foot.

4.02 BASIS OF PAYMENT

A. SEWER MAIN

1. Payment for sewer main will be made at the contract unit price bid per lineal foot of the various sizes and classes called for, which price shall include furnishing and installing pipe; furnishing and placing Type 1 Pipe Bedding; specials required for connection to manholes; testing and all other work necessary or incidental for completion of the item. Trench excavation, backfill, and related work will be paid for under separate items.

B. MANHOLES

1. Payment for manholes will be made at the Contract Unit Price bid each; which price shall include furnishing and installing the manhole and all additional excavation, backfill, manhole ring, and cover required for the installation and completion of the item.

C. SERVICE LINES

1. Payment for sewer services will be made for each of the following bid items as are included in any particular contract:
 - a. Trench excavation and backfill.
 - b. “(Size) (Class) Sewer Service Pipe in Place,” per linear foot.
 - c. Tee or wye (Size) per each.
2. The unit contract prices shall be payment in full for all labor, materials, tools, and other necessary things as may be required to complete the items of work in accordance with the Drawings and the specifications.

END OF SECTION

SECTION 02725 — STORM DRAINS AND CULVERTS

PART 1 GENERAL

1.01 SUMMARY

- A. This section consists of construction of drainage culverts and storm drains, including manholes, inlets and other appurtenant structures, complete.

1.02 REFERENCES

- A. Where reference is made to an ASTM, ANSI or AASHTO designation, it shall be the latest revision at the time of call for Bids, except as noted on the Drawings or in the Special Provisions.
- B. AASHTO M36: Corrugated Steel Pipe, Metallic-Coated, for Sewers and Drains
- C. AASHTO M170: Reinforced Concrete Culvert, Storm Drain, And Sewer Pipe
- D. AASHTO M196: Corrugated Aluminum Pipe for Sewers and Drains
- E. AASHTO M197: Aluminum Alloy Sheet for Corrugated Aluminum Pipe
- F. AASHTO M199: Precast Reinforced Concrete Manhole Sections
- G. AASHTO M206: Reinforced Concrete Arch Culvert, Storm Drain, and Sewer Pipe
- H. AASHTO M207: Reinforced Concrete Elliptical Culvert, Storm Drain, and Sewer Pipe
- I. AASHTO M252: Corrugated Polyethylene Drainage Pipe
- J. AASHTO M294: Corrugated Polyethylene Pipe, 12- to 60-in. Diameter
- K. ASTM A536: Ductile Iron Castings
- L. ASTM C14: Nonreinforced Concrete Sewer, Storm Drain, and Culvert Pipe
- M. ASTM C76: Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe
- N. ASTM C443: Joints for Concrete Pipe and Manholes, Using Rubber Gaskets
- O. ASTM C478: Circular Precast Reinforced Concrete Manhole Sections
- P. ASTM C913: Precast Concrete Water and Wastewater Structures
- Q. ASTM D2321: Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications

1.03 QUALITY ASSURANCE

- A. CERTIFICATION BY MANUFACTURER
1. Contractor shall furnish certification by the manufacturer of the pipe to be furnished on this project, certifying that the pipe complies with the applicable

specifications, when required by Engineer. Required certification shall accompany each delivery of material.

2. All pipe shall be clearly marked with type, class and or, thickness as applicable. Lettering shall be legible and permanent under normal conditions of handling and storage.
3. Type of joint, class, thickness designation, casting, lining, marking, testing, etc., shall be specified.

PART 2 PRODUCTS

2.01 MATERIALS

- A. All storm drain and culvert piping shall be as called out in the Contract Documents and shall be in accordance with materials and testing as specified in this section. Pipe sizes and strength classifications shall be as shown on the Drawings and/or as listed in the Special Provisions.
- B. CORRUGATED STEEL PIPE
 1. Corrugated steel pipe and coupling bands for culverts shall meet the requirements of AASHTO M36 for the specified sectional dimensions.
- C. CONCRETE PIPE
 1. Pipe for Storm Drains and Culverts shall be reinforced concrete pipe conforming to ASTM C76 (AASHTO M170, M207, M206) or non-reinforced concrete pipe conforming to ASTM C14. Joints for concrete pipe shall be rubber gasket type conforming to ASTM C443 or as otherwise specified by Engineer. Non-reinforced pipe shall use only the ASTM C443 type joint.
- D. CORRUGATED ALUMINUM ALLOY CULVERT PIPE[DW15]
 1. This pipe shall conform to the requirements of AASHTO M196 and AASHTO M197.
 - a. Corrugations for pipe designated as 2-2/3 x 1/2 inch shall conform to the requirements of AASHTO M196.
 - b. Corrugations for pipe designated as 3 x 1 inch shall conform to the requirements of AASHTO M196.
- E. HIGH DENSITY POLYETHYLENE (HDPE) PIPE
 1. This pipe shall conform to AASHTO M252 or AASHTO M294.
 2. Installation shall be in accordance with ASTM D-2321.

F. SMOOTH INTERIOR, CORRUGATED POLYETHYLENE PIPE

1. This pipe shall conform to AASHTO M-294, Type S, and as such shall be acceptable for storm and culvert applications when installed according to manufacturer's specifications.

G. MANHOLES

1. Manholes shall be constructed of precast concrete materials with frames and covers in accordance with AASHTO M199 and as shown in the Drawings.
2. Rings and covers shall be in accordance with Owner's Standards. Covers shall be non-ventilated type unless called out otherwise on the Drawings.
3. Adjusting rings may be used for adjusting the manhole top elevation to coincide with existing ground elevations, except the total height of adjusting rings used per manhole shall not exceed 12 inches. Adjusting rings shall be reinforced with the same percentage of steel as the riser and top and shall be supplied with nonslip lugs to match grooves in the precast manhole top.
4. Precast Concrete Rings for manholes shall conform to ASTM C-478.
5. When required, non-corrosive steps of rubber encased steel, aluminum, or nylon shall be used. Steps shall withstand vertical loads of 400 pounds and pull-out resistance of 1,000 pounds.
6. Concrete bases shall be precast or poured in the field on undisturbed earth. Concrete shall conform to Section 03304, PORTLAND CEMENT CONCRETE.

H. INLETS AND CATCH BASINS

1. Catch basins shall be constructed of precast concrete materials with frames and covers in accordance with ASTM C478 or ASTM C913, and as shown in the Drawings.
2. Inlet frames and grates shall be standard cast iron frames and grates of the design shown on the Drawings or as specified in the Special Provisions conforming to ASTM A536.
3. Adjusting and grade rings shall be interlocking rings with level or sloped edge in thickness and shape matching catch basin frame and grate. Include sealant recommended by ring manufacturer.

PART 3 EXECUTION

3.01 PIPE INSULATION

A. RESPONSIBILITY FOR MATERIAL

1. Contractor shall be responsible for all material furnished by him and shall replace at his own expense all such material found defective in manufacture or damaged

in handling after delivery by the manufacturer. This shall include furnishing all material and labor required for the replacement of installed material discovered defective prior to final acceptance of the work or during the guarantee period.

2. Contractor shall be responsible for the safe storage of material intended for the work until it has been incorporated in the completed project.

B. HANDLING OF PIPE

1. All pipe furnished by Contractor shall be delivered and distributed at the site by Contractor. Pipe, fittings and accessories shall be loaded and unloaded by lifting with hoists or skidding to avoid shock or damage. Under no circumstances shall materials be dropped. Pipe handled on skidways shall not be skidded or rolled against pipe already on the ground.
2. In distributing the material at the site of the work, each piece shall be unloaded opposite or near the place where it is to be laid in the trench. The interior of all pipe and other accessories shall be kept free from dirt and foreign matter at all times.
3. Pipe shall be handled so that no coating or lining will be damaged. If, however, any part of the coating or lining is damaged, the repair shall be made by Contractor at his expense in a manner satisfactory to Engineer.

C. LAYING PIPE

1. All pipe shall be laid and maintained to the required lines and grades with fittings, tees and manholes at the required locations.
2. Proper tools and equipment satisfactory to Engineer shall be used by Contractor for the safe and convenient prosecution of the work. All pipe and fittings shall be carefully lowered into the trench in such a manner as to prevent damage to pipe materials and protective coatings and linings. Under no circumstances shall materials be dropped or dumped into the trench.
3. Every precaution shall be taken to prevent foreign material from entering the pipe while it is being installed. At times when pipe laying is not in progress, the open ends of pipe shall be closed by a plug or other means approved by Engineer. Contractor shall clean and remove all sand, gravel, concrete and cement grout that has entered the lines in the process of construction.
4. The bottom of trench shall be shaped to fit the bottom quadrant of the pipe, with holes for joints just large enough to permit assembly.

D. TOLERANCES

1. The sewers shall be installed within 1 inch for grade and shall not be off more than 2 inches for alignment.

E. STORM SEWERS CROSSING WATER MAINS AND SANITARY SEWERS

1. NORMAL CONDITIONS - Storm sewers crossing water mains or sanitary sewer mains shall be laid above or below these mains to provide a vertical separation of at least 18 inches between the bottom of the upper main and the top of the lower main.
2. UNUSUAL CONDITIONS - When local conditions prevent a vertical separation of at least 18 inches, storm sewer mains passing under or over water mains or sewer mains shall be protected by providing:
 - a. Adequate structural support for the mains to prevent excessive deflection of joints and settling on and breaking the lower main; and
 - b. That the full-length of main be centered at the point of crossing so that the joints will be equidistant and as far as possible from the other main.
 - c. That the water main shall be protected by a suitable casing pipe or other protection.

3.02 MANHOLE INSTALLATION

- A. Manholes shall be constructed to the general dimensions shown. Invert channels shall be smooth and semicircular in shape conforming to the inside of the adjacent sewer section. Changes in direction of flow shall be made with a smooth curve of as large radius as the size of the manhole will permit. Changes in size and grade of the channels shall be made gradually and evenly. The invert channels may be formed directly in the concrete of the manhole base or may be half-pipe laid in concrete. The floor of the manhole outside the channel shall be smooth and shall slope toward the channel not less than 1 inch per foot, nor more than 2 inches per foot.
- B. All connections between wall sections or between sewer pipe and manhole walls shall be joined with a watertight seal.
- C. Manhole construction shall be not greater than one manhole distant behind sewer construction, unless approved by Engineer.

3.03 INLETS AND CATCH BASINS

- A. Inlets and catch basins shall be constructed as shown on the Drawings for the type designated.
- B. Inlet structures shall be constructed to the line, cross section and dimensions shown. Concrete and reinforcing steel shall conform to Section 03304, PORTLAND CEMENT CONCRETE and Section 03200, CONCRETE REINFORCEMENT. Inlet structures may be precast or cast-in-place.

3.04**TESTING**

A. LIGHT TEST

After the trench has been backfilled, a light test shall be made between manholes to check alignment and grade for displacement of pipe. Except for curved alignments shown on the Drawings, the completed pipeline shall be such that a true circle of light can be seen from one manhole to the next. If alignment or grade is other than specified and displacement of pipe is found, Contractor shall remedy such defects at his own expense.

B. LEAKAGE TEST

Unless specified in the Special Provisions, a leakage test will not be required. However, this does not preclude the fact that obvious and concentrated leaks (such as open joints, pinched gaskets, cracked barrels or bells, etc.) will not be allowed.

PART 4**METHOD OF MEASUREMENT AND BASIS OF PAYMENT****4.01****METHOD OF MEASUREMENT**

- A. Measurement of storm drain pipe shall be made in lineal feet of the various sizes and classes along the centerline of pipe from center to center of manholes, or center of inlet to center of manhole.
- B. Measurement of culverts shall be made in lineal feet of the various sizes and classes, along the centerline of pipe for the length of pipe installed.
- C. Storm Drain Inlets shall be measured by the number of drain inlets installed, complete in place.
- D. Measurement of manholes shall be made by numerical count each.

4.02**BASIS OF PAYMENT**

- A. The following items shall constitute pay items for the work covered under this Section of the Specifications. Payment for these items shall be full compensation for providing all materials, tools, labor and equipment necessary to complete the item and all incidental work related thereto, whether specifically mentioned herein or not.
- B. Payment for storm drain pipe will be made at the contract unit price bid per lineal foot of the various sizes and classes called for, which price shall include furnishing and installing pipe; furnishing and placing Type 1 pipe bedding; specials required for connection to manholes and inlets; testing and all other work necessary or incidental for completion of the item.
- C. Payment for culvert piping will be made at the contract unit price per lineal foot, which price shall include furnishing and installing pipe, including any specials and all other work necessary or incidental for completion of the item. Flared end sections shall be paid for at unit price bid per each.

- D. Payment for manholes will be made at the Contract Unit Price bid each; price shall include foundation, manhole, ring, cover, ladder steps, backfill, and cover necessary for the installation and completion of item.

END OF SECTION

SECTION 02731 — PRESSURE SEWER LINES AND FORCE MAINS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Pipe and fittings for pressure sewer lines, raw water lines, and force mains.
- B. Valves, thrust blocks, and anchor blocks.

1.02 RELATED SECTIONS

- A. Apply other sections of specifications to the extent required for proper performance of this work.
- B. Section 02190, Aggregates
- C. Section 02220, Trench Excavation
- D. Section 02225, Trench Backfill
- E. Section 02700, Sanitary Sewer Systems

1.03 REFERENCES

- A. ANSI/AWWA C105: Polyethylene Encasement for Ductile Iron Piping for Water and Other liquids.
- B. ANSI/AWWA C110: Ductile-Iron and Gray-Iron Fittings, 3-inch through 48-inch, for Water and Other liquids.
- C. ANSI/AWWA C111: Rubber-Gasket Joints for Ductile Iron and Grey-Iron Pressure Pipe and Fittings.
- D. ANSI/AWWA C115: Flanged Ductile Iron Pipe with Ductile Iron or Gray Iron Threaded Flanges.
- E. ANSI/AWWA C116: Protective Fusion-Bonded Epoxy Coatings for the Interior and Exterior Surfaces of Ductile Iron and Gray Iron Fittings.
- F. ANSI/AWWA C150: Thickness Design of Ductile-Iron Pipe.
- G. ANSI/AWWA C151: Ductile-Iron Pipe, Centrifugally Cast.
- H. ANSI/AWWA C153: Ductile Iron Compact Fittings, 3-inch through 16-inch, for Water and Other Liquids.
- I. ANSI/AWWA C219: Bolted, Sleeve-type Couplings for Plain-end Pipe.
- J. ANSI/AWWA C500: Gate Valves, 3 through 48 inch NPS, for Water and Sewage Systems.
- K. ANSI/AWWA C 504: Rubber Seated Butterfly Valves.

- L. ANSI/AWWA C508: Swing-Check Valves for Waterworks Service, 2-inch through 24-inch NPS.
- M. ANSI/AWWA C509: Resilient Seated Gate Valves, 3-inch through 12-inch NPS, for Water and Sewage Systems.
- N. ANSI/AWWA C520 – Knife Gate Valves, Sizes 2 inch through 96 inch.
- O. ANSI/AWWA C550: Protective Epoxy Interior Coatings for Valves and Hydrants.
- P. ANSI/AWWA C600: Installation of Ductile-Iron Water Mains and Appurtenances.
- Q. ANSI/AWWA C605: Underground Installation of Polyvinyl Chloride (PVC) Pressure Pipe and Fittings for Water.
- R. ANSI/AWWA C900: Standard for Polyvinyl Chloride (PVC) Pressure Pipe, 4 inch through 12 inch, for Water.
- S. ANSI/AWWA C901: Polyethylene (PE) Pressure Pipe and Tubing, ½ inch (13 mm) through 3 inch (76 mm), for Water Service.
- T. ANSI/AWWA C905: Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 14 inch through 48 inch (350 mm through 1200 mm), for Water Transmission and Distribution.
- U. ANSI/AWWA C906: Polyethylene (PE) Pressure Pipe and Fittings, 4 inch (100 mm) through 63 inch (1575 mm), for Water Distribution and Transmission.
- V. ANSI/AWWA C907 – Injection-Molded Polyvinyl Chloride (PVC) Pressure Fittings: 4-inch through 12-inch.
- W. ASTM D1599: Test Method for Short Time Hydraulic Failure Pressure of Plastic Pipe, Tubing, and Fittings.
- X. ASTM D1784: Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
- Y. ASTM D2241: Poly (Vinyl Chloride) (PVC) Plastic Pipe (SDR-PR).
- Z. ASTM D2774: Recommended Practice for Underground Installation of Thermoplastic Pressure Piping.
- AA. ASTM D2855: Making Solvent-Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings.
- BB. ASTM D3035: Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Controlled Outside Diameter.
- CC. ASTM D3139: Joints for Plastic Pressure Pipes using Flexible Elastomeric Seals.
- DD. ASTM D6938 – Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

1.04 SUBMITTALS

- A. Submit under provisions of Section 01300.
- B. Manufacturer's Certificate: Certify that pipe manufacturer is familiar with service requirements, specifications, and installation methods and that the pipe supplied will perform satisfactorily.

1.05 PROJECT RECORD DOCUMENTS

- A. Submit under provisions of Section 01700.
- B. Accurately record actual locations of piping mains, valves, and connections.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect and handle products to site under provisions of Section 01600.

PART 2 PRODUCTS

2.01 PIPE

- A. Ductile Iron Pipe:
 - 1. Pipe:
 - a. ANSI/AWWA C115, C116 - Epoxy Lined, and C151; flanged or mechanical joint, epoxy lined, or alternatives as shown on drawings.
 - b. MJ or Flanged joints.
 - 2. Fittings:
 - a. ANSI/AWWA C110 Ductile iron, standard thickness, flanged or mechanical joint, epoxy lined, or alternatives shown on drawings.
 - b. ANSI/AWWA C153 Ductile iron, standard thickness, mechanical joint, epoxy lined, or alternatives shown on drawings.
 - 3. Pipe Joints: ANSI/AWWA C111, rubber gasket.
 - 4. Jackets: ANSI/AWWA C105, polyethylene encasement.
 - 5. Couplings: ANSI/AWWA C219, Ductile Iron, Bolted, Sleeve-Type Couplings for Plain-End Pipe.
 - 6. Epoxy Lining for DIP shall be two-component epoxy lining system for sewage, such as coal tar epoxy, which combines corrosion resistant characteristics of coal tar pitch with those of epoxy resin. Epoxy lining shall be factory applied.
- B. PVC Pipe (4 inch dia. and larger):
 - 1. Pipe: ANSI/AWWA C900, C905.

2. Fittings:
 - a. ANSI/AWWA C110-Ductile iron, standard thickness, mechanical joint, epoxy lined, or alternatives shown on drawings.
 - b. ANSI/AWWA C153 Ductile iron, standard thickness, mechanical joint, epoxy lined, or alternatives shown on drawings.
 3. Pipe Joints: ASTM D3139 compression gasket ring.
 4. Trace Wire: Insulated 10 gage copper, suitable for direct bury.
 5. Burial Ribbon: 3-inch wide, 4-mil thickness, low-density polyethylene plastic film, blue with "SEWER" printed in black letters, suitable for direct bury.
- C. PVC Pipe (smaller than 4-inch dia.):
1. Pipe: ASTM D2241, ASTM 1784, Grade 1 (12454-B)
- Pressure Rating:
- | | | |
|-------------------------------------|-----|----------------------|
| <u>System Design Pressure Class</u> | vs. | <u>De-rated PVC</u> |
| for Class 100 psi use | | Class 160 psi SDR 26 |
| for Class 150 psi use | | Class 200 psi SDR 21 |
| for Class 200 psi use | | Class 250 psi SDR 17 |
2. Fittings:
 - a. ANSI/AWWA C110 Ductile iron, standard thickness, mechanical joint, epoxy lined, or alternatives shown on drawings.
 - b. ANSI/AWWA C153 Ductile iron, standard thickness, mechanical joint, epoxy lined, or alternatives shown on drawings.
 - c. One piece.
 - d. Class 200.
 3. Pipe Joints: ASTM D3139 compression gasket ring.
 4. Trace Wire: Insulated 10 gage copper suitable for direct bury.
 5. Burial Ribbon: 3-inch wide, 4-mil thickness, low-density polyethylene plastic film, blue with "SEWER" printed in black letters, suitable for direct bury.
- D. Polyethylene Pipe (4inch dia. and larger):
1. ANSI/AWWA C906, Table 3 for 4" diameter.
 2. Iron Pipe Size.
 3. Trace Wire: Insulated 10 gage copper, suitable for direct bury.

4. Burial Ribbon: 3-inch wide, 4-mil thickness, low-density polyethylene plastic film, blue with "SEWER" printed in black letters, suitable for direct bury.
- E. Polyethylene Pipe (2 inch and 3 inch dia.):
1. ANSI/AWWA C901, Table 5.
 2. Iron Pipe Size (IPS).
 3. Trace Wire: Insulated 10 gage copper, suitable for direct bury.
 4. Burial Ribbon: 3-inch wide, 4-mil thickness, low-density polyethylene plastic film, blue with "SEWER" printed in black letters, suitable for direct bury.
- F. Polyethylene Pipe (smaller than 2-inch dia.):
1. ANSI/AWWA C901, Table 7.
 2. Copper Tubing O.D. (CTS).
 3. Trace Wire: Insulated 10 gage copper, suitable for direct bury.
 4. Burial Ribbon: 3-inch wide, 4-mil thickness, low-density polyethylene plastic film, blue with "SEWER" printed in black letters, suitable for direct bury.
- G. Class of Pipe: As shown on drawings.
- H. Joints: As shown on drawings.
- I. Insulation:
1. Field applied 1-inch foam.
 2. Suitable for buried service.
 3. Continuous over all pipe and fittings.

2.02

GATE VALVES

- A. Cast iron body, bronze mounted, resilient-wedge, non-rising stem, open counter clockwise.
- B. Stem seals: Double "O" ring designed so that seal above stem collar can be replaced with valve under pressure in full-open position.
- C. 2-inch valves: Conform to ANSI/AWWA C500 or C509, as approved by Engineer.
- D. 3-inch through 20-inch valves: Conform to ANSI/AWWA C509.
- E. Valves for underground, direct-bury installation:
 1. Mechanical joint ends with transition gaskets if necessary to allow connection to pipe.
 2. Furnish with two-inch square wrench nut for key operation.

3. Furnish with valve box.
 4. If bury depth is over 6 feet, provide bolt-on extension stem to raise wrench nut to within 1.5 feet of ground surface.
 5. Provide one tee-operating wrench 5 feet long.
- F. Valves for inside installation:
1. Flanged ends.
 2. Handwheel operator unless shown otherwise on drawings.
 3. Actuators as shown on drawings.
- G. Epoxy polyamide interior coating conforming to AWWA C550, 8-mil.
- H. Buried valves - 8-mil coal-tar epoxy exterior coating.

2.03

AWWA BUTTERFLY VALVES - BURIED OR VAULT SERVICE

- A. Cast Iron body ASTM A126, Class B with ANSI B 16.1 flange drilling.
- B. Conform to AWWA C504.
- C. Aluminum bronze, ASTM A148-952, or ductile iron, ASTM A536, Grade 65-45-12, disc with 316 SS or monel edge.
- D. SS 18-8 series one piece shaft connected to disc with torque plug.
- E. Field replaceable synthetic rubber valve seats located on body only. ASTM D429, method B.
- F. Self-lubricating, corrosion-resistant, sleeve type bearings designed for vertical and horizontal shaft loadings.
- G. Self-adjusting packing, replaceable without removing actuator.
- H. Leak tested and proof of compliance with AWWA C504, Section 5.5.
- I. Valves for underground, direct-bury installation:
 1. Mechanical joint ends with transition gaskets if necessary to allow connection to pipe.
 2. Furnish with two-inch square wrench nut for key operation.
 3. Furnish with valve box.
 4. If bury depth is over 6 feet, provide bolt-on extension stem to raise wrench nut to within 1.5 feet of ground surface.
 5. Provide one tee operating wrench five feet long.
- J. Valves for inside installation:

1. Flanged ends.
 2. Actuators as shown on drawings.
- K. Epoxy polyamide interior coating conforming to AWWA C550, 8-mil.
- L. Buried valves - 8 mil coal-tar epoxy exterior coating.

2.04

LUGGED BUTTERFLY VALVES - SERVICE INSIDE BUILDINGS

- A. MSS SP-67, rated at 175 psi fully lugged, cast iron body conforming to ASTM A126, Class B.
- B. Field replaceable EPDM seats.
- C. Aluminum bronze disc.
- D. One piece stainless steel stem.
- E. Upper and lower SS lined reinforced Teflon inboard stem bearings and bi-directional stem packing.
- F. Actuators as shown on drawings.
- G. Factory leak tested to 195 psi.
- H. Epoxy polyamide interior coating conforming to AWWA C550, 8-mil.
- I. Keystone Figure AR2 or equal.

2.05

PLUG VALVES

- A. Full round opening permanently lubricated plug type, rubber seat with no obstructions to flow.
- B. Wall thickness in compliance with AWWA C504.
- C. Cast iron body, ASTM A126, Class B.
- D. Flanged ANSI, Class 125, ANSI B16.1.
- E. SS bearings, top and bottom, permanently lubricated.
- F. Balanced plug, ASTM A126, Class B or ASTM A-436 (Ni-Resist) or ductile iron ASTM A536.
- G. Epoxy polyamide interior coating conforming to AWWA C550, 8-mil.
- H. Buried valves - 8 mil coal-tar epoxy exterior coating.
- I. Welded nickel seat.
- J. 150-pound valve rating.

- K. Self-adjusting, wear compensating, packing replaceable without removing bonnet or plug.
- L. Actuator fully isolated from line media.
- M. Leak tested.

2.06 AWWA CHECK VALVES - VAULT SERVICE

- A. Conform to ANSI/AWWA C 508.
- B. Cast iron body.
- C. Outside lever arm and counterweight.
- D. Flanged ANSI, Class 125.
- E. Epoxy polyamide interior coating conforming to AWWA C550, 8-mil.

2.07 WAFER CHECK VALVES - SERVICE INSIDE BUILDINGS

- A. External spring.
- B. Rating - 125 pound ANSI.
- C. Cast iron body, ASTM A126, Class B.
- D. 316 SS disc and arm.
- E. Bronze bushings.
- F. EPDM seat.
- G. 316 SS spring.
- H. EPDM shaft seal.

2.08 VALVE BOXES

- A. Cast iron, 5-¼ inches diameter.
- B. Adjustable screw type of sufficient length for pipe bury required.
- C. Cast iron cover with arrow indicating direction of opening.

2.09 DIAPHRAGM VALVES

- A. Flanged cast iron, ASTM A126.
- B. Straightway body, full uniform port.
- C. Liner: Neoprene rubber.
- D. Bonnet: Ductile iron, ASTM A395.
- E. Diaphragm: Natural rubber.

2.10 VALVE ACTUATORS

- A. Electric Actuators for Diaphragm Valves:
 - 1. Limitorque L 120-10.
 - 2. 3 phase, 208 Volt.
 - 3. Mounted and tested.
 - 4. Controller: Keystone LC-2, 4-20 mA input, 4-20 mA output, self-tuning option. control module.
 - 5. Gear Operators - Manufacturer's standard.
- B. Lever Operators - Manufacturer's standard.

2.11 JOINT RETAINERS

- A. Manufacturers: EBAA Iron Sales, Inc. Series 1600 Restraint Harness or 2000 PV Mechanical Joint Restraint or approved equal.
- B. Cast from ductile iron.
- C. Provide a sufficient number of ductile tie bolts to restrain working and test pressures.

2.12 FROST PROTECTION

- A. Comply with details shown on drawings.
- B. 2 inch thick rigid Styrofoam insulation board ("Blue Board").

2.13 ACCESSORIES

- A. Concrete for Thrust Blocks, Anchor Blocks, and Gate Valve Surface Pads: Class B.
- B. Polyethylene Wrap – 8-mil minimum thickness.

2.14 PIPE EMBEDMENT MATERIAL

- A. As specified in Section 02190, AGGREGATES.
- B. Bedding and Haunching Material:
 - 1. Type A, B, or C, for HDPE and DIP, unless otherwise indicated on
 - 2. Drawings.
 - 3. Type C, for PVC and PVCO, or as approved by Engineer.
- C. Initial Backfill Material:
 - 1. Type A, unless otherwise indicated on Drawings.

PART 3 EXECUTION

3.01 PREPARATION

- A. Excavate trench in accordance with Section 02220, TRENCH EXCAVATION.
- B. Remove scale and dirt on inside of pipe before assembly.

**3.02 SEPARATION REQUIREMENTS OF POTABLE WATER LINES AND SEWERS, STORM DRAINS,
OR IRRIGATION LINES**

- A. Definitions:
 - 1. Separation requirements shall apply to sanitary sewer lines, storm drains (storm sewers), raw water, and irrigation lines and manholes or structures associated with these lines.
 - 2. Within this section, "sewer line" shall mean any of the lines listed above and "sewer manhole" shall mean any of the structures associated with the lines listed above.
- B. Parallel Installation:
 - 1. Lay water lines at least 10 feet horizontally from any sewer line measured edge to edge of pipe.
 - 2. No water lines shall pass through or come into contact with any part of a sewer manhole.
 - 3. When a horizontal separation of 10 feet is not possible, maintain bottom of water line at least 18 inches above the top of the sewer line.
 - 4. When horizontal separation of 10 feet and vertical separation of 18 inches is not possible, use one of the following methods:
 - a. Construct sewer line of materials and with joints that are equivalent to water main standards of construction and pressure test prior to backfilling.
 - b. Place water or sewer line in a separate casing pipe. Provide adequate structural support for casing to prevent settling and deflection of joints.
 - c. Use cement-treated backfill as outlined below.
- C. Water Line Crossing Above Sewer Line:
 - 1. Maintain vertical separation of at least 18 inches between bottom of water line and the top of sewer line.
 - 2. If a vertical separation of 18 inches is not possible, use one of the following methods:
 - a. Place sewer line in a separate casing pipe. Joints in sewers at crossing shall be located at least 10 feet from water lines.

b. Use cement-treated backfill as outlined below.

D. Water Line Crossing Below Sewer Line:

1. Use one of the following methods:

a. Place sewer line in a separate casing pipe. Provide adequate structural support for casing to prevent settling and deflection of joints. Center the length of sewer pipe at point of crossing, so that joints will be equal distance and as far as possible from water line.

b. Use cement-treated backfill as outlined below.

E. Cement-treated Backfill:

1. Place cement-treated backfill, in lieu of pipe casing specified in Paragraphs B, C, and D, if approved by Engineer.
2. Place cement-treated backfill on undisturbed trench bottom and extend to 2 inches above upper utility for 10 feet on each side of the pipe intersection.
3. Cement-treated backfill to conform to Section 02225, TRENCH BACKFILL.
4. Place cement-treated backfill as appropriate to maintain utility lines and grade.

3.03

PIPE EMBEDMENT

A. Place pipe embedment material in accordance with Section 02225, TRENCH BACKFILL.

3.04

PIPE

- A. Install pipe to provide depth of cover indicated on drawings.
- B. Install PVC Pipe to ANSI/AWWA C605.
- C. Install HDPE Pipe to ASTM D2774.
- D. Install ductile iron piping and fittings to ANSI/AWWA C600.
- E. Route pipe in straight line unless indicated otherwise on drawings.
- F. Install pipe to allow for expansion and contraction without stressing pipe or joints.
- G. Form and place concrete for thrust blocks at each fitting, or install joint retainers as indicated on drawings.
- H. Backfill trench in accordance with Section 02225, TRENCH BACKFILL.
- I. Install piping to conserve building space and not interfere with use of space.
- J. Provide access to valves and fittings.
- K. Where pipe supports are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.

- L. Prepare pipe, fittings, supports, and accessories not pre-finished, ready for finish painting.
- M. Install valve upright or horizontal, not inverted.
- N. Install pipe supports as indicated on drawings.
- O. Set buried valves on solid bearing.
- P. Center and plumb valve box over valve. Set box cover flush with grade.
- Q. Conform to manufacturer's recommendations for installing pipe, valves and fittings.

3.05 PIPE INSTALLED FROM TOP OF TRENCH: PIPE MAY BE JOINTED ON THE TRENCH BANK AND LOWERED INTO THE TRENCH, IF THE FOLLOWING REQUIREMENTS ARE MET:

- A. Comply with Parts 3.3 and 3.4.
- B. Use equipment capable of centering pipe over trench as it is being lowered into place to prevent pipe from contacting trench wall.
- C. Maintain the string of pipe being handled under sufficient compressive force to prevent joints from separating.
- D. Use "free-flowing" pipe embedment material.

3.06 TRACE WIRE

- A. Place in trench on top of all non-metallic piping.
- B. Underground Connections:
 - 1. Use crimp connector with copper sleeve joint.
 - 2. Tape or cover to maintain integrity of insulation.
- C. Provide continuity between terminals.
- D. Install terminal at all manholes, air/vac valves, clean-outs, and at intermediate locations along pipeline to provide maximum spacing between terminals of 2,000 feet.

3.07 BURIAL RIBBON

- A. Place on trench backfill 2 feet above top of pipe, for all force main locations.

3.08 VALVES

- A. Set valves on solid bearing.
- B. Center and plumb valve box over valve. Set box cover flush with finished grade. Pour concrete surface pad flush with finished grade.
- C. Wrap with polyethylene.

- D. Form and place concrete and rebar for anchor blocks at each valve.

3.09 FITTINGS

- A. Conform to Manufacturer's recommendations.
- B. Wrap cast iron or ductile iron fittings in polyethylene.
- C. Form and pour concrete for thrust blocks at each fitting.

3.10 THRUST BLOCKS

- A. Dampen soil or place polyethylene in trench.
- B. Pour thrust block.
- C. Cover thrust block with polyethylene.
- D. For Immediate Backfilling:
 - 1. After 30 minutes, carefully place 1.5 feet of backfill without distorting concrete.
 - 2. Complete backfill and compaction within 60 minutes of starting thrust block placement.

3.11 HYDROSTATIC TESTING

- A. Pipe and appurtenances shall be pressure tested in accordance with the appropriate AWWA Standard depending on pipe material.

PART 4 METHOD OF MEASUREMENT AND BASIS PAYMENT

4.01 METHOD OF MEASUREMENT

- A. FORCE MAIN
 - 1. Measurement of force mains shall be made in lineal feet of the various sizes and classes, along the centerline of pipe through all valves, fittings, and appurtenances.
- B. VALVES
 - 1. Measurement of force main valves shall be made by numerical count of the sizes and types of valves listed in the Proposal.
- C. FITTINGS
 - 1. Measurement of force main fittings will be by numerical count of the various types and sizes listed in the Proposal.
- D. THRUST BLOCKS
 - 1. Measurement of valve thrust blocks shall be made by numerical count of each size type listed in the bid schedule actually installed.

(Alternative) Measurement of valve thrust blocks shall be made by the bearing area approved by Engineer, measured to the nearest 0.1 square foot.

E. PIPE INSULATION

1. Measurement of pipe insulation shall be made in linear feet along the centerline of the installed insulation.

4.02

BASIS OF PAYMENT

A. FORCE MAIN

1. Payment for force main will be made at the contract unit price bid per lineal foot of the various sizes and classes called for, which price shall include furnishing and installing pipe; furnishing and placing bedding; testing and all other work necessary or incidental for completion of the item. Trench excavation, backfill, and related work will be paid for under separate items.

B. VALVES

1. Payment for force main valves will be made at the Contract Unit Price bid each; which price shall include furnishing and installing the valve and valve box, all additional excavation, backfill, and special compaction required for the installation, and all other work necessary or incidental for completion of the item.

C. FITTINGS

1. Payment for fittings will be made at the contract unit price bid for each fitting, which price shall include furnishing and installing the fittings as required, thrust blocking and any other work necessary or incidental for completion of the item.

D. THRUST BLOCKS

1. Payment for this item will be made at the Contract Unit Price bid each; which price shall include all additional excavation, installation (including all bolts, strapping and concrete), backfill and compaction.

(Alternative) Payment for this item will be made at the contract unit price bid per square foot of bearing area.

E. PIPE INSULATION

1. Payment for pipe insulation will be made at the contract unit price per linear feet of insulation, which price shall constitute full compensation for furnishing all labor, equipment, material, transportation, and incidentals necessary to install the pipe insulation as described herein and shown on the drawings.

END OF SECTION

SECTION 02776 — CONCRETE SIDEWALKS, DRIVEWAY APPROACHES, CURB TURN FILLETS, VALLEY GUTTERS AND MISCELLANEOUS NEW CONCRETE CONSTRUCTION

PART 1 GENERAL

1.01 SUMMARY

- A. Concrete sidewalk and driveway approaches, curb turn fillets, valley gutters, new monument boxes and other miscellaneous new concrete construction shall consist of air-entrained Portland Cement Concrete constructed in accordance with these specifications. This work shall be in reasonably close conformity with the lines and grades, thicknesses, and typical cross sections shown on the plans or established by Engineer.

1.02 REFERENCES

- A. AASHTO T180: Standard Method of Test for Moisture-Density Relations of Soils Using a 10-lb Rammer and an 18-in. Drop.

PART 2 PRODUCTS

2.01 MATERIALS

- A. PORTLAND CEMENT CONCRETE - Air-entrained Portland Cement Concrete shall conform to the requirements of Section 03304, PORTLAND CEMENT CONCRETE, Subsection 2.08, Class 4000.
- B. REINFORCING STEEL - Reinforcing steel shall conform to the requirements of Section 03200, CONCRETE REINFORCEMENT.
- C. PREFORMED EXPANSION JOINT MATERIAL - Joint material shall conform to the requirements of Section 03251, EXPANSION AND CONTRACTION JOINTS.

PART 3 EXECUTION

3.01 GENERAL

- A. Sidewalks and driveway approaches, either new or replacement, valley gutters and curb turn fillets shall be constructed at the locations shown on the plans and where directed by Engineer, and shall be in accordance with these specifications and plans.
- B. The quantity of driveway approaches, concrete driveway replacement and concrete sidewalk replacement shown in the Proposal is an estimate and may be increased or decreased without an adjustment in unit prices as these items shall be considered "minor items."

3.02 SUBGRADE AND BASE COARSE PREPARATION

- A. The subgrade shall be excavated or filled with suitable material to the required grades and lines.
- B. All soft, yielding and otherwise unsuitable material shall be removed and replaced with suitable material. Filled sections shall be compacted and extended a minimum of 1 foot outside the form lines.
- C. The subgrade shall be 95 percent of maximum dry density as determined by AASHTO T180 Modified Proctor Density.
- D. When required on the plans base course will be installed to the required grade in accordance with Section 02231, AGGREGATE SUB-BASE AND BASE COURSES.

3.03 ERECTING FORMS

- A. Forms, wood or steel, shall be staked securely in place, true to line and grade.
- B. Sufficient support shall be given to the form to prevent movement in any direction, resulting from the weight of the concrete or the concrete placement.
- C. Forms shall be clean and well-oiled prior to setting in place.
- D. When set, the top of the form shall not depart from grade more than 1/4 inch when checked with a 10-foot straightedge. The alignment shall not vary more than 1/2 inch in 10 feet.
- E. Immediately prior to placing the concrete, forms shall be carefully inspected for proper grading, alignment and rigid construction. Adjustments and repairs as needed shall be completed before placing concrete.

3.04 PLACING AND FINISHING CONCRETE

- A. The subgrade or base course shall be properly compacted and brought to specified grade before placing concrete.
- B. The subgrade or base course shall be thoroughly dampened immediately prior to the placement of the concrete.
- C. Concrete shall be spaded and tamped thoroughly into the forms to provide a dense, compacted concrete free of rock pockets.
- D. The exposed surfaces shall be floated, finished and broomed.
 - 1. The surface of concrete shall be finished true to the lines and grades shown on the plans.
 - 2. Concrete shall be worked until the coarse aggregate is forced down into the body of the concrete and no coarse aggregate is exposed. The surface shall then be floated with a wooden float to a smooth and uniform surface.

3. When the concrete has hardened sufficiently, the surface shall be given a broom finish. The broom shall be of an approved type. The strokes shall be square across the concrete from edge to edge with adjacent strokes overlapped. Strokes shall be made without tearing the concrete. The broomed finish shall produce regular corrugations not over 1/8 inch in depth.
 4. Concrete that is adjacent to forms and formed joints shall be edged with a suitable edging tool to the dimensions shown on the plans.
- E. The rate of concrete placement shall not exceed the rate at which the various placing and finishing operations can be performed in accordance with these specifications.

3.05 STRIPPING FORMS

- A. Forms may be removed at such time as the concrete is sufficiently set that removal will be without danger of chipping or spalling.
1. When forms are removed before the expiration of the curing period, the edges of the concrete shall be protected with curing compound.
 2. All forms shall be cleaned, oiled and be examined for defects before they are used again.

3.06 PROTECTION

- A. Contractor shall always have materials available to protect the surface of the plastic concrete against rain. These materials shall consist of waterproof paper or plastic sheeting.
- B. When concrete is being placed in cold weather and temperature may be expected to drop below 35°F, suitable protection shall be provided to keep the concrete from freezing until it is at least 72 hours old. Concrete damaged by freezing shall be removed and replaced at Contractor's expense.

3.07 CURING

- A. Curing shall be in accordance with Section 03370, CONCRETE CURING.

3.08 JOINTS

- A. Preformed Expansion Joints shall be installed at the locations shown in the Drawings.
- B. Contraction joints shall be provided between expansion joints at the intervals noted in the Drawings. Joints in new construction shall match joints in adjacent existing concrete.

3.09 BACKFILL

- A. In areas where lawns exist or as shown on the plans, the top 4 inches of backfill bringing its level up to the top of the sidewalk or driveway shall be black loam or good topsoil which is suitable for the growth of lawns.

1. It shall be placed out from the sidewalk or driveway a sufficient distance and in amount to replace turf or lawn removed during installation.
 2. Backfill shall be completed by grading to match the existing lawn.
- B. Where lawns do not exist, the top 4 inches of backfill shall be impervious dirt and shall be placed to conform to the typical sections shown on the plans.
- C. Backfill shall be compacted to a density equal to the adjacent materials. It shall be leveled off to a neat and free draining surface.

3.10 TOLERANCES

- A. The work shall be performed in a manner which results in the item being constructed true to line and grade, uniform in appearance and structurally sound.
- B. Items found with unsightly bulges, ridges, low spots or other defects shall be removed and replaced at Contractor's expense if Engineer considers them to be irreparable.
- C. When checked with a 10-foot straightedge, grade shall not deviate by more than 1/4 inch and alignment shall not vary by more than 1/2 inch.
- D. Final elevation shall not depart from plan elevation by more than 1/2 inch.

PART 4 METHOD OF MEASUREMENT AND BASIS OF PAYMENT

4.01 METHOD OF MEASUREMENT

- A. CURB TURN FILLETS - This item shall be measured by the square foot, in plan view, of curb turn fillets constructed, complete in place, including curb.
- B. CONCRETE VALLEY GUTTERS - This item shall be measured by the square foot.
- C. NEW CONCRETE SIDEWALK - This item shall be measured by the square foot.
- D. SURVEY MONUMENTS - This item shall be measured and paid for by the number of monuments constructed where shown on the plans at the contract unit price bid for "Install Monuments".

4.02 BASIS OF PAYMENT

- A. CURB TURN FILLETS - Payment shall constitute full compensation for all material, excavation, backfill, curing of concrete, pre-molded mastic material, welded wire mesh, equipment, tools and labor and for the performance of all work and incidentals necessary to complete this item.
- B. CONCRETE VALLEY GUTTERS - Payment shall constitute full compensation for all material, excavation, backfill, curing of concrete, pre-molded mastic material, reinforcing steel, equipment, tools and labor and for the performance of all work and incidentals necessary to complete this item.

- C. NEW CONCRETE SIDEWALK - Payment shall constitute full compensation for all material, excavation, backfill, curing of concrete, pre-molded mastic material, equipment, tools and labor and for the performance of all work and incidentals necessary to complete this item.
- D. SURVEY MONUMENTS - Payment shall constitute full compensation for all materials, excavation, backfill, forming and curing of concrete, equipment, tools and labor and for the performance of all incidentals necessary to complete this item.
- E. Payment shall be made under:
- | | |
|-------------------------|-------------|
| Curb Turn Fillets | square foot |
| Concrete Valley Gutters | square foot |
| New Concrete Sidewalk | square foot |
| Survey Monuments | per each |
- F. Payment shall be made at the contract unit price bid for each item multiplied by the number of units installed.

END OF SECTION

SECTION 02805 — RELOCATION STREET SIGNS, UTILITY POLES AND MAILBOXES

PART 1 GENERAL

1.01 SUMMARY

- A. This work shall consist of the removal and/or relocation of street signs, traffic control signs, utility poles, street lights and mailboxes.
- B. Location of street signs and private mailboxes “to be removed”, are approximately only. The survey for curb or sidewalk alignment as a part of actual construction shall be the determining factor as to which of these facilities are to be moved or removed by Contractor or others.

1.02 REFERENCES

- A. US DOT FHWA Manual for Uniform Traffic Control Devices (MUTCD) for Streets and Highways

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 CONSTRUCTION METHODS

- A. STREET AND TRAFFIC CONTROL SIGNS. Engineer’s decision to move or relocate street or traffic control signs shall be based on the location of the sign with respect to curb line, sidewalk line and the staked grading limits.
- B. Signs within the staked grading limits whose existing location (both vertically and horizontally) conform to final plan location within a 6-inch tolerance will not be relocated. If no street signs exist, then new ones shall be installed.
- C. Signs within the staked grading limits whose existing location does not conform to final plan location tolerance above will be relocated. Signs outside the staked grading limit shall also be relocated to conform to final plan location.
- D. The preservation of the street, stop and other traffic control and direction signs that are to remain in place shall be the responsibility of Contractor while the job is under construction. Should any of the signs need to be moved for Contractor’s convenience, they shall be removed by Contractor, either temporarily reinstalled or stored, and permanently reinstalled when construction or curb and gutter is completed. Contractor shall be held liable for any damage to these signs caused by neglect on his part and no extra compensation will be allowed for preserving, removing or replacing stop and other traffic control and direction signs designated to remain in place, but rather this work shall be considered as included in the contract unit prices for the various items of the contract.

- E. Street, stop and other traffic control and direction signs designated to be relocated shall be removed and reinstalled in the locations shown on the Drawings or designated by Engineer.
- F. The following procedures will be followed in removing and relocating both signs removed by Contractor for his convenience, and signs, designated by Engineer for relocation:
 - 1. After it has been determined which signs shall be relocated at project expense, and which signs Contractor will remove and replace for his convenience, Engineer will be notified which street, stop and traffic direction signs are to be removed and reinstalled.
 - 2. Upon receiving Contractor's notification, a representative of Owner will inspect the signs with Contractor to determine the condition of the signs. Signs which require repair will be delivered by Contractor to Owner. Signs not requiring repair will be removed and reinstalled as specified below. Signs delivered to Owner will be repaired and ready for pickup within 48 hours, unless new street signs are required to be ordered from the factory.
 - 3. Where stop signs and traffic direction or control signs are removed, Contractor shall place a properly flared barricade in the center of the street, and temporarily install a similar stop sign or traffic direction sign on the barricade. This temporary sign shall remain in place until Contractor permanently reinstalls the stop or traffic control signs.
 - 4. Street signs may be installed temporarily upon approval by Engineer.
 - 5. Signs not required or used for temporary installation shall be stored.
 - 6. All stop, traffic direction, street signs, or control signs shall be reinstalled in the permanent location shown on the Drawings or designated by Engineer as soon as possible after the curb or curb and gutter forms have been removed. Signs which have been damaged after removal shall be replaced with new signs at Contractor's expense.
- G. All sign locations shall conform to the latest issue of the Manual on Uniform Traffic Control Devices for Streets and Highways published by the U.S. Department of Transportation.
- H. Failure of Contractor to permanently reinstall signs within 48 hours period after written notice will result in Owner reinstalling the sign and withholding the cost of the work from Contractor's estimate.
- I. Private Mailboxes. Private mailboxes within the staked grading limits generally are not shown on the Drawings. Mailboxes within the staked grading limits designated for relocation by Engineer shall be removed by Contractor and temporarily installed outside, but immediately adjacent to the construction limits. Mailboxes shall be reinstalled in accordance with U.S. Post Office regulations.

- J. Power, Street Lights, and Telephone Poles. It shall be Contractor's responsibility to coordinate the removal or relocation of utility poles with the utility owner.

PART 4 METHOD OF MEASUREMENT AND BASIS OF PAYMENT

4.01 METHOD OF MEASUREMENT

- A. Street, stop and traffic control or direction signs designated for relocation shall be measured by the number of street, stop, and traffic control or direction signs relocated.
- B. Private mailboxes designated for relocation shall be measured by the number of mailboxes relocated.

4.02 BASIS OF PAYMENT

- A. Payment for street stop and traffic control and direction signs designated for relocation shall be paid for at the unit price measured as relocated. The cost of removing, temporarily reinstalling, storing, and permanently reinstalling these signs will be included in the unit price bid for relocating such signs.
1. Those signs or devices moved by Contractor for his convenience shall be reinstalled at no cost to Owner.
- B. Payment for private mailboxes relocated shall be paid for at the unit price bid multiplied by the number of units measured as relocated.
- C. Private Mailboxes. Existing private mailboxes removed by Contractor for his convenience shall be reinstalled at no cost to Owner.
- D. Payment for the above items shall constitute full compensation for all materials, excavation, temporary reinstallation, forming and curing of concrete equipment, tools and labor and for the performance of all work and incidentals necessary to complete the item.

END OF SECTION

SECTION 02895 — ENGINEERING FABRIC

PART 1 GENERAL

1.01 SUMMARY

- A. This section covers materials and work associated with providing engineering fabric for drainage and filtration, erosion control, separation and stabilization, embankment, and retaining wall reinforcement, and asphalt paving. The fabrics covered in this section shall be woven or non-woven fabric consisting only of long chain polymeric filaments or yarns such as polyethylene, polyester, polyamide, or polyvinylidene-chloride formed into a stable network such that the filaments or yarns retain their relative positions to each other.

1.02 REFERENCES

- A. AASHTO M288: Geosynthetic Specification for Highway Applications

1.03 SUBMITTALS

- A. Submit for approval name of fabric and installation procedures.

1.04 QUALITY ASSURANCE

- A. Provide products of acceptable manufacturers which have been in satisfactory use in similar service for three years. Use experienced installers. Deliver, handle, and store materials in accordance with manufacturer's instructions. All test methods shall be in accordance with latest ASTM procedures.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Fabric shall comply with the indicated application as described in AASHTO M288, and as listed in the Special Provisions or on the Drawings.

PART 3 EXECUTION

3.01 PACKAGING AND ON SITE STORAGE

- A. Engineering fabric shall be uniformly rolled onto a cardboard core and shall be wrapped in plastic to protect the material from moisture and damage during shipment. Protective wrapping shall be left on the fabric until installation. The product must not be allowed to get wet prior to installation to prevent weakening of the cardboard core. Rolls shall be externally tagged for easy field identification. External tagging shall include the following: 1) Name of Manufacturer; 2) Product type; 3) Product grade; 4) Lot number; and, 5) Physical dimensions.

3.02 INSTALLATION

- A. Install materials and systems in accordance with manufacturer's instructions and approved submittals. Install materials and systems in proper relation with adjacent construction. Coordinate with work of other sections.

PART 4 METHOD OF MEASUREMENT AND BASIS OF PAYMENT

4.01 METHOD OF MEASUREMENT

- A. Engineering fabric shall be measured by the square yard excluding overlaps and seam allowances.

4.02 BASIS OF PAYMENT

- A. Engineering fabric shall be paid for at bid schedule unit prices in place. Price quoted for fabric shall include all installation charges for placing fabric as shown on drawings. Contractor shall be responsible for any damage that occurs to the fabric during installation and will replace the damaged fabric at no additional cost.

END OF SECTION

SECTION 02900 — LANDSCAPING

PART 1 GENERAL

1.01 SUMMARY

- A. Provide topsoil and lawns.
- B. Provide trees and shrubs.
- C. Provide soil amendments and fertilizer.
- D. Provide seeding and mulching.

1.02 SUBMITTALS

- A. Submit for approval product and maintenance data, and dryland seed mixture.

1.03 QUALITY ASSURANCE

- A. A qualified landscape installer should be used.
- B. Seeds and plant materials shall be furnished in accordance with Wyoming State Statutes (WSS) § 11-12-101 through 125 and § 11-9-101 through 109 and shall conform with the Wyoming Weed and Pest Control Act of 1973.

1.04 DELIVERY, STORAGE AND HANDLING

- A. Deliver fertilizer in unopened containers bearing the manufacturer's statement of analysis.
- B. Adequately protect root balls at all times from sun, drying winds and frost. Do not prune plants prior to delivery. If balled and burlapped plants are not installed immediately upon delivery, set on the ground and protect well with moist soil or wet mulch.
- C. Deliver, store and handle other materials in accordance with manufacturer's instructions.

1.05 WARRANTY

- A. Warrant trees and shrubs for a period of 1 year after Substantial Completion, against defects including death and unsatisfactory growth, except for defects resulting from Owner's neglect, abuse by others, or natural phenomena. Replace unsatisfactory plant material at end of warranty period. One replacement is required.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Plant Material: Trees and shrubs shall be nursery-grown, with botanical and common names of plants true to the approved names given in the latest edition of "Hortus,"

and shall meet the requirements of American Standard for Nursery Stock (ANSI Z60.1). Plants shall be sound, healthy, vigorous, symmetrically proportioned, well-branched, densely foliated when in leaf, free of diseases and insect pests, eggs, larvae, and have well-developed root systems.

- B. Topsoil: Obtain from local source(s) having similar soil characteristics to that at the site. Obtain from well-drained site(s) where topsoil occurs in a depth of not less than 4 inches. Do not obtain from bogs or marshes. Topsoil shall be fertile, friable, natural loam, reasonably free of subsoil, clay lumps, brush, weeds, litter, roots, stumps, stones larger than 2 inches in any dimension, or any other material which would inhibit the germination of seeds or the growth of the cover crop.
- C. Lawns, seed: New crop seed mixture, composed principally of common Kentucky Bluegrass, or as approved. Other acceptable varieties include Merion, Baron and Fylking.
- D. Lawns, sod: Vigorous, viable, strongly rooted sod, not dormant or less than 2 years old, free of weeds and undesirable native grasses, insect infestations and fungus, and machine cut to a pad thickness of 1 inch + 1/4 inch. Sod shall be composed principally of Kentucky Bluegrass (*Poa pratensis*), testing 99.9 percent pure, or as approved. Other acceptable varieties include Tall Fescue and Brome.
- E. Trees and shrubs: See schedule on Drawings.
- F. Soil amendments: Organic matter such as pine needles, leaf mold, or peat.
 - 1. Shredded peat moss shall be commercial grade of either sphagnum moss, reed, or sedge peat, taken from fresh water site, free of lumps, roots and stones, with texture and pH range suitable for intended use.
 - 2. Well-rotted and shredded manure.
 - 3. Treble superphosphate.
- G. Fertilizer: Commercial grade of neutral character, with some elements derived from organic sources.
- H. Dryland seed: The following is only a suggestion and may not be applicable or available statewide. Consult the local Soil Conservation Service for appropriate seed species and application rates.

Grass Species	P.L.S. LBS./AC
Bottlebrush Squirreltail	0.75
Canby Bluegrass, Canbar	0.75
Indian Ricegrass, Nespar	2.50
Streambank Wheatgrass, Sodar	4.00
Western Wheatgrass, Rosana	5.00

These types and percentages may vary. Mixture may be available commercially as "Dryland Pasture Mix."

I. Mulch

1. Trees and shrubs: Well-aged fibrous or shredded bark, old sawdust, pine needles, or leaf mold.
2. Dryland seeding: Certified weed free small grain straw or native hay.
3. Pigmented wood cellulose fibers or paper pulp for hydraulic seeding. Mulch shall form a blotter-like ground cover with moisture absorption and percolation properties, and the ability to cover and hold the seed in contact with the topsoil, yet not inhibit the penetration of seedlings through it.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Topsoil: Spread topsoil to a uniform depth of 6 inches over all areas scheduled to receive lawns. Fertilize proposed lawns at rate specified herein. Fine grade areas to a firm even surface, free from lumps or stones. Installation of sod may be done immediately after fine grading, provided the bed is in good condition and not muddy or hard. If it is hard, scarify to a friable condition again.
- B. Lawns, seed
1. If soils are predominantly clayey or sandy, peat moss or manure shall be spread uniformly at a rate of 3 cubic yards per 1000 square feet, and worked into the soil.
 2. Apply superphosphate at a rate of 10 pounds per 1000 square feet.
 3. Apply seed, at rate of 2 pounds per 1000 square feet, using a drop (band) type spreader. Divide seed into two halves and distribute one half in the north-south direction, and the other half from east to west.
 4. Rake seed into the soil and commence light watering, at least four times per day for two weeks, or until seed germinates.
- C. Lawns, sod
1. Lay sod parallel to the direction of the slope and in a manner permitting butt joints to alternate. Fit sod pieces tightly together so that no joint is visible and tamp sod firmly and evenly by hand.
 2. Roll sod with a 150-pound roller to level and seal seams. After rolling, water sod until water soaks through into topsoil to a depth of not more than 3 inches.
 3. Water, weed and replace sod, if required, until Substantial Completion. Erect and maintain temporary protection devices where deemed necessary.
 4. Mow sod at least twice before Substantial Completion. At the time of the first mowing, set mower blades to produce 2-1/2-inch mowed height.

D. Trees and shrubs

1. Mark planting area for tree and shrub pits that is five times the diameter of the root ball. Do not proceed with planting until the bed and pit locations are approved by Engineer.
2. Loosen soil with rototiller or shovels to a depth of 12 inches. Add organic matter, distributed uniformly within planting bed.
3. In the center of the prepared area, excavate a shallow hole for the root ball, so that it sits on solid subsoil. Apply fertilizer directly to bottom of pit.
4. Set plant in center of pit, plumb and straight, and at such a level that, after settlement, the top of the root collar is even with adjacent finished grade. Remove burlap, ropes, and all wire. Gently pack soil around plant and lightly water, to promote further soil consolidation.
5. Apply 2 inches thick layer of mulch.
6. Prune each plant with clean, sharp tools to remove suckers, and broken, badly bruised or dead branches. Wrap tree trunks with TUBEX, or equivalent translucent material.
7. Guy trees with 2 wires anchored securely to steel posts, directly opposite each other, not less than 5 feet from the trunk. Protect the tree from direct contact with the wires. Remove posts and wires after one year.
8. Commence watering and maintenance of plantings until Substantial Completion.
9. Correct defective work as soon as it becomes apparent and as weather and season permit.

E. Seeding: Broadcasting will not be allowed.

1. Prior to seeding, areas that have become muddy or hard shall be scarified to a depth of 4 inches, and left in a friable condition. Fertilize at a rate of 40 pounds of available nitrogen per acre.
2. Drilling: Drills shall be set for uniform rows with spacing not to exceed 8 inches, and depth for the type of seed being drilled, for a distribution rate of 13 pounds per acre, or as recommended by the local Soil Conservation Service.
3. Dry mulching: Spread mulch uniformly over the seeded area at a rate of 2 tons per acre. Anchor mulch in the soil with a smooth or serrated coulter disc.
4. Hydraulic methods: Use equipment designed for such work. Seed and water shall be uniformly applied to the areas scheduled to be seeded. Fertilizer, water and approximately 1 ton per acre of hydraulic mulch shall be homogeneously mixed and uniformly applied to seeded areas.

F. Fertilizer

1. Lawns: Farm-type, such as 18-46-0, applied at 5 pounds per 1000 square feet of lawn area, or 16-20-0, at 7 pounds per 1000 square feet. Provide nitrogen in a form that will be available to lawns during initial growth period. Established lawns shall not receive more than 1.5 pounds of soluble nitrogen per 1000 square feet, applied 4 times annually.
2. Trees and shrubs: Not less than 5 percent total nitrogen, 10 percent available phosphoric acid, and 5 percent soluble potash.
3. Dryland seeding: Not less than a 2:1:1 ratio of nitrogen, phosphorous and potassium.

PART 4 METHOD OF MEASUREMENT AND BASIS OF PAYMENT

4.01 METHOD OF MEASUREMENT

- A. Measurement shall not become necessary if landscaping is bid as lump sum.
- B. If unit prices are called for in the Bid Schedule measurement of each item will be made as the number of units used or installed.

4.02 BASIS OF PAYMENT

- A. Unless otherwise called out in the contract payment for landscaping shall be lump sum.
- B. When unit prices are called for in the Bid Schedule payment shall be made at unit prices for each of the various items multiplied by the number of units installed or incorporated in the work.

END OF SECTION

SECTION 02915 — UNIT PAVERS

PART 1 GENERAL

1.01 SUMMARY

- A. Furnish and place base course, setting bed and interlocking concrete unit pavers, at the following locations, in the quality, shape, thickness and color specified. Coordinate with work of other sections.
 - 1. Driveways and streets.
 - 2. Walkways and plazas.

1.02 REFERENCES

- A. ASTM C140: Standard Test Methods for Sampling and Testing Concrete Masonry Units and Related Units
- B. ASTM C902: Pedestrian and Light Traffic Paving Brick
- C. ASTM C936: Solid Concrete Interlocking Paving Units

1.03 SUBMITTALS

- A. Submit for approval samples, and manufacturer's product data, installation instructions, and maintenance data. Prepare for approval 4-foot by 4-foot mock-ups. Provide a pallet of extra stock at Substantial Completion.

1.04 QUALITY ASSURANCE

- A. Comply with applicable sections of these specifications for base course and setting bed preparation, and with ASTM C936. Provide products of acceptable manufacturers which have been in satisfactory use in similar service for three years. Use experienced installers. Deliver, handle, store, and install pavers in accordance with manufacturer's printed instructions and approved submittals.
- B. Manufacturer and Installer shall each provide a 2-year written guarantee from the date of Substantial Completion.
- C. Randomly select five pavers for testing in accordance with ASTM C140 to verify the average compressive strength is no less than 8000 psi, with no individual paver less than 7200 psi. Submit test results to Engineer.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Brick pavers, ASTM C902, frost-resistant type:
 - 1. Heavy-duty type for vehicular traffic.

2. Intermediate-duty type for pedestrian traffic.
- B. Concrete pavers: Solid units with interlocking design, such as UNI-Stone, by Pavestone Co., Phoenix, Arizona. Pavers shall be 3-1/8-inch thick. Color shall be Terra Cotta.
- C. Asphalt block pavers: Solid asphalt cement units.
- D. Setting bed: Well-graded, clean, washed sand with 100 percent passing a 3/8-inch sieve, and a maximum of 3 percent passing a No. 200 sieve.
- E. Bituminous setting bed with neoprene mastic with sand filled joints.
- F. Mortar setting bed over concrete slab with pigmented grout at joints. Provide control and expansion joints.
- G. Base course: Comply with Section 02231, AGGREGATE SUB-BASE AND BASE COURSES, of these specifications.
- H. Joints: Clean masonry type sand containing at least 30 percent of 1/8-inch particles.

PART 3 EXECUTION

3.01 PREPARATION

- A. The base course shall be shaped to grade and cross-section, and compacted as specified in Section 02210, EXCAVATION AND EMBANKMENT, to a uniform depth of 6 inches, held 4-1/8 inches below finish grade.
- B. Spread and screed the setting bed sand evenly over the prepared base coarse to a uniform compacted depth of 1-1/4 inches. Do not disturb this course once the desired elevation is achieved.

3.02 PLACEMENT

- A. Place the pavers in a herringbone pattern with nominal joint width of 1/8 inch between adjacent pavers, with no joint exceeding 1/4 inch. Alternately select pavers from at least 3 pallets, working from top to bottom in each pallet stack. Use a double-headed breaker or masonry saw for cutting pavers.
- B. Pavers shall be seated into the sand bedding course with a plate vibrator capable of 3000 to 5000 pounds compaction force with the surface clean and the joints open.
- C. After vibration, spread masonry type sand over the surface, allow to dry, and vibrate so as to completely fill the joints. Surplus material shall be swept from the surface after joints are completely filled with sand.
- D. Remove and replace any damaged pavers. Clean and protect work from damage.

PART 4 METHOD OF MEASUREMENT AND BASIS OF PAYMENT

4.01 METHOD OF MEASUREMENT

- A. Unit Pavers shall be measured for payment by the square foot.

4.02 BASIS OF PAYMENT

- A. Basis of payment shall include paver, setting bed, base coarse, joint filler and all materials and labor to complete the installation.
- B. Payment shall be made at the contract unit price bid multiplied by the number of units (square feet) placed.

END OF SECTION

SECTION 03100 — CONCRETE FRAMEWORK

PART 1 GENERAL

1.01 SUMMARY

- A. Formwork for cast-in-place concrete
- B. Openings in formwork for other affected work
- C. Form accessories such as snap ties, bracing, etc.
- D. Stripping formwork

1.02 DEFINITIONS

- A. Shoring: The activity to support formwork.
- B. Re-shoring: The activity to reduce the amount of formwork supporting concrete elements. As concrete sets and strength increases, less need for formwork occurs gradually until concrete becomes free standing.

1.03 REFERENCES

- A. ACI 347: Recommended Practice for Concrete Formwork.

1.04 SUBMITTALS

- A. Shop Drawings: Fabrication and erection drawings of forms for specific finished concrete surfaces, as indicated. Show general construction of forms, jointing, special joints or reveals, location and pattern of form tie placement, and other items affecting exposed concrete visibility.
- B. Form Release Agent: Where concrete surfaces are scheduled to receive special finishes or applied coverings which may be affected by agent submit manufacturer's instructions for use of agent.

1.05 QUALITY ASSURANCE

- A. Design, engineering, and construction of formwork are Contractor's responsibility.
- B. Standards: Comply with all pertinent provisions of the ACI 347.
- C. Qualification of Worker: Provide at least one person who shall be present at all times during the work of this Section and who shall be thoroughly familiar with the type of materials being installed, the reference standards, and the requirements of this work.
- D. Design Forms
 - 1. With sufficient strength to maintain finished tolerances indicated in Section 03345, CONCRETE FINISHING, to support loads, pressures, and allowable stresses as outlined in ACI 347.

2. To permit easy removal.
3. For required finishes.

E. Product Handling

1. Take all means necessary to protect formwork materials before, during, and after installation and to protect the installed work of other trades. In the event of damage, immediately make all repairs and replacements necessary to the approval of Engineer and at no additional cost to Owner.

1.06 **JOB CONDITIONS**

- A. For reference purposes, establish and maintain sufficient control points and bench marks to check tolerances. Maintain in an undisturbed condition and until final completion and acceptance of Work.
- B. Regardless of tolerances specified, allow no portion of Work to extend beyond legal boundaries.

1.07 **FIELD SAMPLES**

- A. Prepare field samples and submit in accordance with Section 01340, SUBMITTALS.

PART 2 **PRODUCTS**

2.01 **FORM MATERIALS**

- A. Construct formwork for concrete concealed from view with plywood sawn boards of sound grade or steel forms as approved by Engineer.
- B. Provide form material with sufficient thickness to withstand pressure of newly placed concrete without excessive and objectionable bow or deflection.
- C. Do not use material with raised grain, patches, or other defects which will impair texture of concrete surface.

2.02 **FORMWORK ACCESSORIES**

- A. Form ties and spreaders
 1. Provide factory-fabricated, removable or snap-off metal form ties, designed to prevent form deflection and to prevent spalling concrete surfaces upon removal.
 2. Provide ties so that portion remaining within concrete after removal of exterior parts is at least 1-1/2 inches from the outer concrete surface. Provide form ties that will not leave a hole larger than 1-inch diameter in the concrete surface. The portion of the tie remaining in the concrete after removal of the exterior parts shall not project beyond surface of the concrete.

3. Wire ties will be permitted where surfaces on either side of a formed member will not be exposed to view or painted. Projecting ends of wire ties shall be cut off flush with the concrete surfaces. Job fabricated ties will not be acceptable.
- B. Pre-molded Expansion Joint Filler: Unless indicated otherwise, provide Type F1, in accordance with Section 03251, EXPANSION AND CONTRACTION JOINTS.
- C. Form Release Agent
1. Provide commercial formulation form release agent compounds that will not bond with, stain, nor adversely affect concrete surfaces requiring bond or adhesion, nor impede the wetting of surfaces to be cured with water or curing compounds.
 2. Surplus oil on forms and form oil on reinforcing steel and construction joints shall be removed before concrete is placed.
- D. Fillets for Chamfered Corners: Wood strips 3/4-inch x 3/4-inch size; maximum possible length.

2.03

DESIGN OF FORMWORK

A. General

1. Design, erect, support, brace, and maintain formwork so that it will safely support vertical and lateral loads that might be applied, until such loads can be supported by the concrete structure.
2. Carry vertical and lateral loads to ground by formwork system and in-place construction that has attained adequate strength for that purpose.
3. Construct formwork so that concrete members and structures are of correct size, shape, alignment elevation, and position.
4. Design forms and falsework to include assumed values of live load, dead load, weight of moving equipment operated on formwork, concrete mix, height of concrete drop, vibrator frequency, ambient temperatures, foundation pressures, stresses, lateral stability, and other factors pertinent to safety of structure during construction.
5. Support form facing materials by structural members spaced sufficiently close to prevent objectionable deflection.
6. Fit forms placed in successive units for continuous surfaces to accurate alignment, free from irregularities, and within allowable tolerances.
7. Provide formwork sufficiently tight to prevent leakage of cement paste during concrete placement. Solidly butt joints and provide backup material at joints as required to prevent leakage and fins.

PART 3 EXECUTION

3.01 SURFACE CONDITIONS

- A. Examine the substrata and conditions under which work of this Section is to be performed and correct unsatisfactory conditions which would prevent proper and timely completion of the Work. Do not proceed until unsatisfactory conditions have been corrected.

3.02 FORM CONSTRUCTION

- A. Construct forms complying with ACI 347, to the exact sizes, shapes, lines, and dimensions shown, and as required to obtain accurate alignment, location, grade, level, and plumb work in finished structures.
- B. Provide for openings, offsets, keyways, recesses, moldings, reglets, chamfers, blocking, screed, bulkheads, anchorages, inserts, and other features required. Use selected materials to obtain required finishes.
- C. Forms for openings and construction which accommodates installation by other trades whose materials and products must be fabricated before the opportunity exists to verify the measurements of adjacent construction which affects such installations, shall be accurately sized and located as dimensioned on the Drawings. In the event that deviation from the Drawing dimensions results in problems in the field, Contractor shall be responsible for resolution of the conditions as approved by Engineer without additional expense to Owner.
- D. Fabrication: Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush plates or wrecking plates where stripping may damage cast concrete surfaces. Kerf wood inserts for forming keyways, reglets, recesses, and the like, to prevent swelling and assure ease of removal.
- E. Provision for other trades: Provide openings in concrete formwork to accommodate work of other trades. Verify size and location of openings, recesses, and chases with the trade requiring such items. Accurately place and securely support items to be built into forms.
- F. Cleaning: Thoroughly clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before concrete is placed.

3.03 FORM COATINGS

- A. Coat form contact surfaces with form-coating compound before reinforcement is placed. Do not allow excess form coating material to accumulate in the forms or to come into contact with surfaces which will be bonded to fresh concrete. Apply in compliance with manufacturer's instructions.

3.04 INSTALLATION OF EMBEDDED ITEMS

- A. General: Set and build into the work anchorage devices and other embedded items required for other work that is attached to, or supported by, cast-in-place concrete. Use setting drawings, diagrams, instructions, and directions provided by suppliers of the items to be attached thereto.
- B. Edge forms and screed strips for slabs: Set edge forms or bulkheads and intermediate screed strips for slabs to obtain required elevations and contours in the finished slab surface. Provide and secure units to support types of screeds required.

3.05 REMOVAL OF FORMS

- A. Forms shall be removed in a manner to insure complete safety of the structure. Forms shall not be removed until concrete has sufficient strength to carry its own weight and the loads upon it with safety. Due to weather conditions or for other reasons, the forms shall remain in place for longer periods than stated above, when directed by Engineer.
- B. Do not pry against face of concrete. Use only wooded wedges.
- C. When repair of surface defects or finishing is required at an early age, remove forms as soon as concrete has hardened sufficiently to resist damage from removal operations.
- D. Formwork for columns, walls, sides of beams, and other members not supporting the weight of concrete may be removed as soon as the concrete has hardened sufficiently to resist damage from removal.
- E. Where no re-shoring is planned, leave forms and Shoring used to support weight of concrete in beams, slabs, and other concrete members in place until concrete has attained its specified strength.
- F. Where re-shoring is planned, supporting formwork may be removed when concrete has reached 70 percent of specified strength, provided re-shoring is installed immediately.

3.06 RE-SHORING

- A. When re-shoring is permitted or required, plan operations in advance and obtain approval.
- B. During re-shoring, do not subject concrete in beam, slab, column, or any other structural member to combined dead and construction loads and live loads in excess of loads permitted for developed concrete strength at time of re-shoring.
- C. Place re-shoring as soon as practical after stripping operations are complete, but in no case later than end of working day on which stripping occurs.
- D. Tighten re-shoring to carry required loads without overstressing.

- E. Leave re-shoring in place until the concrete being supported has reached its specified strength.
- F. For floors supporting shoring under newly placed concrete, level original supporting shoring or re-shoring.
 - 1. Re-shoring system shall have a capacity to resist anticipated loads in all cases equal to at least 1/2 the capacity of the shoring system.
 - 2. Unless otherwise specified, locate re-shoring directly under shoring.
 - 3. In multistory buildings, extend re-shoring through a sufficient number of stories to distribute the weight of newly placed concrete, forms, and construction live loads in such a manner that design loads of floors and support shoring are not exceeded.
- G. Design, engineering, and construction of shoring and re-shoring are the responsibility of Contractor.

3.07 REMOVAL STRENGTH

- A. When removal of formwork or re-shoring is based on concrete reaching a specified strength, it shall be assumed that concrete has reached this strength when either of the following conditions have been met:
 - 1. When test cylinders, field cured along with the concrete they represent, have reached the specified strength.
 - 2. When concrete has been cured in accordance with provisions of Section 03370 for the same length of time as the site-cured cylinders which reached specified strength. Determine the length of time the concrete has been cured in the structure by cumulative number of days or fractions thereof, not necessarily consecutive, during which the air temperature is above 50°F and concrete has been damp or sealed from evaporation and loss of moisture.

3.08 RE-USE OF FORMS

- A. Clean and repair surfaces of forms to be re-used in the Work. Split, frayed, delaminated, or otherwise damaged form-facing material will not be acceptable. Apply new form coating compound material to concrete contact surfaces as specified for new formwork. When forms are re-used for successive concrete placement, thoroughly clean surfaces, remove fins and laitance, and tighten forms to close all joints. Align and secure joints to avoid offsets.

3.09 FIELD QUALITY CONTROL

- A. Before commencing a placement, verify connections, form alignment, ties, inserts, and shoring are placed and secure.

- B. Observe formwork continuously while concrete is being placed to verify that the forms are plumb and there are no deviations from desired elevation, alignment, or camber.

PART 4 METHOD OF MEASUREMENT AND BASIS OF PAYMENT

4.01 METHOD OF MEASUREMENT

- A. Unless otherwise noted in the special provisions, no separate measurement will be made for items under this section. Full compensation shall be considered as included in the prices paid for the various contract items and no additional compensation will be allowed.

4.02 BASIS OF PAYMENT

- A. Unless otherwise noted in the special provisions, no separate payment will be made for items under this section. Full compensation shall be considered as included in the prices paid for the various contract items and no additional compensation will be allowed.

END OF SECTION

SECTION 03200 — CONCRETE REINFORCEMENT

PART 1 GENERAL

1.01 SUMMARY

- A. Reinforcing steel bars, wire fabric, or rod mats for cast-in-place concrete.
- B. Support chairs, bolsters, bar supports, and spacers for supporting reinforcement.
- C. Fiber reinforced concrete.

1.02 REFERENCES

- A. AASHTO M254: Corrosion Resistant Coated Dowel Bars.
- B. ACI 301: Specifications for Structural Concrete for Buildings.
- C. ACI 315: Details and Detailing of Concrete for Buildings.
- D. ASTM A82: Steel Wire, Plain, for Concrete Reinforcement.
- E. ASTM A185: Steel Welded Wire, Fabric, Plain, for Concrete Reinforcement.
- F. ASTM A615: Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
- G. ASTM A706: Low-Alloy Steel Deformed Bars for Concrete Reinforcement.
- H. AWS D1.1: Structural Welding Code Steel.
- I. AWS D1.4: Structural Welding Code Reinforcing Steel.
- J. CRSI Document: Manual of Standard Practice.
- K. ASTM C94: Ready-Mixed Concrete
- L. ASTM C1116: Fiber-Reinforced Concrete
- M. ASTM C1018: Flexural Toughness and First-Crack Strength of Fiber-Reinforced Concrete (Using Beam with Third-Point Loading) (Withdrawn 2006)

1.03 SUBMITTALS

- A. Manufacturer's Certificate: Submit mill test certificates of supplied concrete reinforcement, indicating physical and chemical analysis.
- B. Welder's certification.
- C. Shop Drawings.
 - 1. Indicate sizes, spacings, locations, and quantities of reinforcing steel, wire fabric, bending and cutting schedules, splicing, stirrup spacing, supporting, and spacing devices.

2. When required, Shop Drawings shall be prepared under the direction of a Wyoming licensed professional engineer acceptable to the agency having jurisdiction.

1.04 PRODUCT HANDLING

- A. Delivery: Deliver reinforcement to the job site bundled, tagged, and marked. Use metal tags indicating bar size, lengths, and other information corresponding to markings shown on placement diagrams.
- B. Storage: Take all means necessary to protect reinforcement materials before, during, and after installation and to protect the installed work of other trades. Store all reinforcement materials in a manner to prevent excessive rusting and fouling with grease, dirt, and other bond-breaking coatings. Take all necessary precautions to maintain identification after bundles are broken. In the event of damage or errors, immediately make all repairs or replacements necessary and at no additional cost to Owner.

1.05 FIBER REINFORCED CONCRETE

- A. Submit 1 copy of manufacturer's printed product data, clearly marked, indicating proposed fibrous concrete reinforcement materials. Printed data should state 1.5 pounds of fiber to be added to each cubic yard of each type of concrete.
- B. Submit 1 copy of a manufacturer's printed batching and mixing instructions.
- C. Submit 1 copy of a certificate prepared by the Concrete supplier stating that the approved fibrous concrete reinforcement materials at the rate of 1.5 pounds per cubic yard were added to each batch of concrete delivered to the project site. Each certificate shall be accompanied by 1 copy of each batch delivery ticket indicating amount of fibrous concrete reinforcement material added to each batch of concrete.

PART 2 PRODUCTS

2.01 CONCRETE REINFORCEMENT MATERIALS

- A. Reinforcing Steel: In accordance with ASTM A615 deformed bars, grade, and type as indicated, including supplementary requirements S1, either uncoated or as indicated. When no grade is indicated, use 60 ksi yield grade steel. Use ASTM A706 steel if welding is indicated or allowed.
- B. Welded Steel Wire Fabric: In accordance with ASTM A185 plain type; in flat sheets or coiled rolls either uncoated or as indicated.
- C. Stirrup Steel: In accordance with ASTM A82.
- D. Plain Dowel Bars for Expansion Joints: In accordance with ASTM A615, 60 ksi yield grade steel.
 1. Epoxy coated in roadway pavements.

2. Provide metal dowel cap at one end of dowel to permit longitudinal movement of dowel within concrete section. Design caps with one end closed.
 3. Provide for movement equal to joint width plus 1/2 inch.
 4. For load transfer bars, paint with 1 coat of paint conforming to AASHTO M254 and coat half with grease.
- E. Fibrous Concrete Reinforcement Material
1. 100 percent virgin polypropylene, fibrillated fibers containing no reprocessed olefin materials and specifically manufactured to an optimum gradation for use as concrete secondary reinforcement. Volume per cubic yard shall equal a minimum of 0.1 percent (1.5 pounds).
 2. Physical Characteristics:
 - a. Specific gravity: 0.91
 - b. Tensile strength: 50 to 110 ksi (345 to 759 MPa).
 - c. Fiber length: graded per manufacturer; or, as specified by Engineer.
 3. Fibrous concrete reinforcement materials provided in this Section shall produce concrete conforming to the requirements for each type and class of concrete required, as indicated on the Drawings and specified in the appropriate Section.

2.02 ACCESSORY MATERIALS

- A. Tie Wire: Minimum 16 gage steel wire shall be plain, cold-drawn and shall comply with ASTM A82.
- B. Supports for reinforcement: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcement in place:
 1. Use wire bar type supports complying with CRSI recommendations unless otherwise indicated. Do not use wood, brick, and other unacceptable materials.
 2. For slabs on grade, use supports with sand plates or horizontal runners where base material will not support chair legs.
 3. For exposed-to-view concrete surfaces, where legs of supports are in contact with forms, provide supports with either hot-dip galvanized or plastic protected legs.

2.03 FABRICATION

- A. Fabricate reinforcement in accordance with ACI 315, providing for the concrete cover specified in Section 03304, PORTLAND CEMENT CONCRETE.
- B. Locate reinforcing splices not indicated on drawings at points of minimum stress. Indicate location of splices on Shop Drawings.
- C. Weld reinforcing bars in accordance With AWS D1.4.

- D. Unacceptable materials: Reinforcement with any of the following defects will not be permitted in the Work:
1. Bar lengths, depths, and bends exceeding specified fabrication tolerances.
 2. Bends or kinks not indicated on Drawings or final Shop Drawings.
 3. Bars with reduced cross-section due to excessive rusting or other cause.

PART 3 EXECUTION

3.01 PLACING

- A. All reinforcement to be free of loose mill scale, loose or thick rust, dirt, paint, oil or grease.
- B. Place all reinforcement in the exact position indicated. With tie wire, tie bars together at all intersections.
- C. Maintain the distance from vertical forms and between layers of reinforcement by means of prefabricated chairs, ties, hangers, or other approved devices. Placing and fastening of reinforcement in each section of the Work must be approved before concrete is placed.
- D. Overlap sheets of metal mesh one square plus 6 inches to maintain a uniform strength. Securely fasten at the ends, edges, and supports to maintain clearances.

3.02 SPLICING

- A. Furnish all reinforcement in the full lengths indicated unless otherwise permitted. Splicing of bars, except where indicated is not permitted without written approval. Stagger splices where possible.
- B. Unless indicated otherwise, overlap reinforcing bars a minimum of 30 diameters to make the splice. In lapped splices, place the bars and wire to maintain the minimum distance for clear spacing to the surface of the concrete.
- C. Do not use lap splices on bars greater in diameter than No. 11 unless approved.
- D. Weld reinforcing steel only if indicated or if authorized in writing. Weld in conformance to AWS D1.4.
- E. Do not bend reinforcement after embedding in hardened concrete.
- F. Do not permit reinforcement or other embedded metal items bonded to the concrete, to extend continuously through any expansion joint, except dowels in floors bonded on only one side of joints.

3.03 PLACING EMBEDDED ITEMS

- A. Place all sleeves, inserts, anchors, and embedded items prior to concrete placement. Temporarily fill voids in embedded items to prevent entry of concrete.

- B. Give all trades whose work is related to the concrete Section ample notice and opportunity to introduce or finish embedded items before concrete placement.

3.04

CONSTRUCTION METHODS FOR FIBER REINFORCED CONCRETE

- A. Add fibrous concrete reinforcement to concrete materials at the time concrete is batched in amounts in accord with approved submittals for each type of concrete required.
- B. Mix batched concrete in strict accord with fibrous concrete reinforcement manufacturer's instructions and recommendations for uniform and complete dispersion.

PART 4

METHOD OF MEASUREMENT AND BASIS OF PAYMENT

4.01

METHOD OF MEASUREMENT

- A. The cost of the fibrous concrete reinforcing is to be included as a part of the appropriate item in which it is being used. There will be no separate measurement or payment for this item.
- B. Reinforcing steel will be measured by the pound, based on the theoretical number of pounds, excluding splice bars to replace test samples, complete in place as shown on plans or placed as ordered.
- C. The quantities of materials furnished and placed shall be based upon the calculated weights of the reinforcing steel actually placed in accordance with these specifications. No deductions will be made for any bends except for hooks. The length of the bar to be added to out-to-out dimensions of hooked bars will be shown on the plans. The weights calculated shall be based upon the following table:

Size	Weight per L.F. in lbs	Size	Weight per L.F. in lbs
		#8	2,670
#3	0.376	#9	3,400
#4	0.668	#10	4,303
#5	1,043	#11	5,313
#6	1,502	#14	7,650
#7	2,044	#16	13,600

- D. The weights estimated for spiral spacers will be based on 3/4 pound per linear foot. The weight of the spiral will be computed using the core diameter shown on the plans. Wire mesh, when included as a pay item, will be based on the weights shown on the plans for the type of mesh designated.

4.02

BASIS OF PAYMENT

- A. The accepted quantities of reinforcing steel will be paid for at the contract unit price per pound complete in place. No allowance will be made for clips, wires, or other material used for fastening reinforcement in place.

Payment will be made under:

PAY ITEM

Reinforcing Steel

PAY PER UNIT

Lb.

END OF SECTION

SECTION 03251 — EXPANSION AND CONTRACTION JOINTS

PART 1 GENERAL

1.01 SUMMARY

- A. Joints and joint sealants in horizontal traffic surfaces for cast-in-place concrete sidewalks, curb, gutter, and pavement slabs.

1.02 REFERENCES

- A. ASTM C920: Elastomeric Joint Sealants.
- B. ASTM D545: Standard Methods of Testing Preformed Expansion Joint Filler for Concrete Construction (Non-extruding and Resilient Types).
- C. ASTM D994: Preformed Expansion Joint Filler for Concrete (Bituminous Type).
- D. ASTM D1056: Flexible Cellular Materials - Sponge or Expanded Rubber.
- E. ASTM D1190: Concrete Joint Sealer, Hot-Poured Elastic Type.
- F. ASTM D1191: Standard Method for Testing Concrete Joint Sealers.
- G. ASTM D1751: Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Non-extruding and Resilient Bituminous Types).
- H. ASTM D1752: Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction.
- I. ASTM D1850: Concrete Joint Sealer, Cold-Application Type.
- J. ASTM D1851: Standard Methods of Testing Concrete Joint Sealers, Cold-Application Type.
- K. ASTM D2240: Standard Test Method for Rubber Property - Durometer Hardness.
- L. ASTM D2628: Preformed Polychloroprene Elastomeric Joint Seals for Concrete Pavements.
- M. ASTM D3405: Joint Sealants, Hot-Poured, for Concrete and Asphalt Pavements.
- N. ASTM D3406: Joint Sealant, Hot- Applied, Elastomeric-Type, for Portland Cement Concrete Pavements.
- O. ASTM D3407: Standard Methods of Testing Joint Sealants, Hot-Poured, for Concrete and Asphalt Pavements.
- P. ASTM D3408: Standard Methods of Testing Joint Sealants, Hot-Poured, Elastomeric-Type, for Portland Cement Concrete Pavements.
- Q. ASTM D3542: Preformed Polychloroprene Elastomeric Joint Seals for Bridges.

- R. ASTM D3569: Joint Sealant, Hot- Applied, Elastomeric, Jet-Fuel-Resistant-Type for Portland Cement Concrete Pavements.
- S. ASTM D3581: Joint Sealant, Hot- Poured, Jet-Fuel-Resistant-Type, for Portland Cement Concrete and Tar-Concrete Pavements.
- T. ASTM D3582: Standard Methods for Testing Joint Sealant, Hot-Poured, Jet-Fuel-Resistant-Type, for Portland Cement Concrete and Tar-Concrete Pavements.
- U. ASTM D3583: Standard Methods of Testing Joint Sealant, Hot-Applied, Elastomeric-Type, for Portland Cement Concrete Pavements, or Joint Sealant, Hot-Applied, Elastomeric, Jet- Fuel-Resistant-Type for Portland Cement Concrete Pavements.
- V. FS SS-S-200: Sealants, Joint, Two Component, Jet-Blast Resistant, Cold-Applied, for Portland Cement Concrete Pavement.

1.03 SUBMITTALS

- A. Manufacturer's certification that product was manufactured, tested, and supplied in accordance with source quality control requirements specified herein, together with a report of the test results and the date each test was completed.
- B. Manufacturer's instruction for joint preparation, type of cleaning, and installation.
- C. Manufacturer's Product Data and Samples for each joint sealant product required.
- D. Safety data sheets.

1.04 QUALITY ASSURANCE

- A. Obtain joint sealing materials from a single manufacturer for each different product required.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to site in original unopened containers or bundles with labels identifying manufacturer, product name and designation, color, expiration period for use, pot life, cure time, and mixing instructions for multicomponent materials.
- B. Store and handle materials in compliance with manufacturer's recommendations to prevent deterioration; or damage due to moisture, high or low temperatures, contaminants, or other causes.

1.06 SYSTEM PERFORMANCES

- A. Pavement joints include longitudinal and transverse expansion joints, contraction joints, construction joints, and crack control joints.
- B. Provide joint sealants that maintain watertight and airtight continuous seals.

PART 2 PRODUCTS

2.01 GENERAL

- A. Compatibility: Provide joint filler, sealant backings, sealants, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience.

2.02 JOINT VOID - FORMER

- A. Plastic with a water stop.
- B. 1/4 depth of concrete structural section.

2.03 JOINT FILLER – SHEET TYPE

- A. F1 Joint Filler: Bituminous (asphalt or tar) mastic in accordance with ASTM D994; formed and encased between 2 layers of bituminous saturated felt or 2 layers of glass-fiber felt.
- B. B2 Joint Filler: Cane or other cellulosic fiber in accordance with ASTM D1751; saturated with asphalt.
- C. F3 Joint Filler: Granulated cork in accordance with ASTM D1751; in an asphalt binder; encased between 2 layers of asphalt saturated felt or 2 layers of glass-fiber belt.
- D. F4 Joint Filler: Sponge rubber fully compressible in accordance with ASTM C1752; with resiliency recovery rate of 90 percent minimum.
- E. F5 Joint Filler: Cork in accordance with ASTM C1752; impregnated and bound with asphalt; compressible with resiliency recovery rate of 90 percent if not compressed more than 50 percent of original thickness.
- F. F6 Joint Filler: Plastic foam (for cold-applied sealants only) preformed, compressible, resilient, non-waxing, non-extruding strips of flexible, non-gassing plastic foam; non-absorbent to water and gas; 30 pounds per cubic feet density maximum; and of size and shape to control sealant depth and performance.

2.04 JOINT FILLER – BACKER ROD AND TAPE TYPE

- A. Elastomeric Tube (Backer Rod): Neoprene, butyl, EPDM, or silicone tubing complying with ASTM D1056, non-absorbent to water and gas, capable of remaining resilient at temperatures down to -26°F. Provide product with low compression set and of size and shape to provide a secondary seal, to control sealant depth, and otherwise contribute to optimum sealant performance.
- B. Tape: Self-adhesive polyethylene bond breaker tape or other plastic tape as recommended by sealant manufacturer for preventing sealant from adhering to joint filler materials or joint surfaces at back or bottom of joint.

2.05 JOINT SEALANT - GENERAL

- A. Color of exposed joint sealant indicated, or if not, as selected from manufacturer's standard colors.

2.06 JOINT SEALANT – HOT-APPLIED

- A. HAS1 Sealant: Resilient and adhesive compound type in accordance with ASTM D3405; for portland cement concrete or asphalt concrete pavements.
- B. HAS2 Sealant: Thermoplastic type in accordance with ASTM D3581; jet-fuel resistant without rubber unless indicated otherwise.
- C. HAS3 Sealant: Elastic type in accordance with ASTM D1190.
- D. HAS4 Sealant: Elastomeric type in accordance with ASTM D3406; one component, for Portland Cement concrete pavements.
- E. HAS5 Sealant: Elastomeric type in accordance with ASTM D3569; one component, jet-fuel resistant, for portland cement concrete pavements.

2.07 JOINT SEALANT – COLD-APPLIED

- A. CAS1 Sealant: Elastomeric type in accordance with ASTM C920; Chemically curing, for vehicular or pedestrian use, and types of construction other than highway and airfield pavements and bridges and joint substrates indicated; Types S or M; Grade P or NS; Class 25; Use T, NT, M and O.
 - 1. Self-leveling.
 - 2. Shore A Hardness: 40 ± 5 ASTM D2240.
 - 3. Final cure: 4 days maximum.
 - 4. Service range: -10 to 150°F.
- B. CAS2 Sealant: Mastic type in accordance with ASTM D1850; single or multiple component; for joints having a minimum width of 1/2 inch.
- C. CAS3 Sealant: Coal-tar modified urethane type in accordance with FS SS-S-200; one part, jet fuel resistant; Type H.
- D. CAS4 Sealant: Elastomeric preformed polychloroprene type with lubricant adhesive and indicated movement ratio.
 - 1. For concrete pavement seal; ASTM D2628.
 - 2. For concrete bridge seals; ASTM D3542.

2.08 SOURCE QUALITY CONTROL

- A. Preformed Expansion Joint Fillers: Non-extruding and resilient types; ASTM D545.

- B. Hot-Applied Joint Sealants:
 - 1. Elastic type used in concrete pavements, bridges, other structures; ASTM D1191.
 - 2. Bituminous type for hydraulic and asphaltic concrete pavements; ASTM D3407.
 - 3. Elastomeric type of hydraulic concrete pavements; ASTM D3408.
- C. Jet-Fuel-Resistant Joint Sealant: Hot-applied; ASTM D3582 and ASTM D3583.
- D. Cold-Applied Mastic Joint Sealant: In accordance with ASTM D1851.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Do not proceed with installation of joint sealants under unfavorable weather conditions.
- B. Install elastomeric sealants when temperature is stable in temperature range recommended by manufacturer for installation.
- C. Joint Substrate Conditions: Do not proceed with installation of joint sealers until contaminants capable of interfering with their adhesion are removed from joint substrates.

3.02 PREPARATION

- A. Clean, prepare, and size joints in accordance with manufacturer's instructions. Remove any loose materials and other foreign matter which might impair adhesion of sealant.
- B. Verify that joint shaping materials and release tapes are compatible with sealant.
- C. Examine joint dimensions and size materials to achieve required width to depth ratio.
- D. Adjust joint depths to allow sealants to perform properly.
- E. Remove moisture on substrate.
- F. Bond Breaker Tape: Install where needed or required by manufacturer's recommendations to ensure that elastomeric sealants will perform properly.

3.03 JOINTS - GENERAL

- A. Construct all joints as follows.
 - 1. At right angles to top surface of placement.
 - 2. Straight unless indicated otherwise.
 - 3. Before uncontrolled shrinkage cracking takes place.
 - 4. To prevent concrete edge slump.

3.04**EXPANSION JOINTS**

- A. Expansion joints shall be in location as shown on drawings or as approved by Engineer. Joints in exterior concrete work shall be placed:
 - 1. Where shown on Drawings;
 - 2. 32 feet 0 inches on center maximum for pavement slabs, or;
 - 3. 100 feet on center maximum for sidewalks, curbs, and gutters.
- B. Pre-molded filler strips shall extend full depth of slab.
- C. Isolation joints shall be used in all areas where slabs abut vertical surfaces. Joint material shall be placed on levels called for and in good alignment.
- D. In no case shall the reinforcing or other fixed metal items embedded or bonded into concrete be run continuous through expansion joint.
- E. Finish at joints shall be neatly finished with an edging tool providing a slightly rounded edge on each side of the joint filler material.
- F. Expansion joint material shall be placed in sidewalks, curbs, and gutters at all Points of Curvature, Points of Tangent, and curb turns.

3.05**CONSTRUCTION JOINTS**

- A. Construction joints shall be placed in flat slabs in locations as shown on the drawings or as approved by Engineer.
- B. The preformed metal keyway joints shall be set to obtain accurate alignment, grades, level and plumb in the work and shall be furnished the full depth of the slab.
- C. Where a joint is made to a previously placed concrete section, care should be taken to remove all laitance prior to new placement of concrete.
- D. Contractor may elect to place concrete on both sides of a construction joint or placing through the joint. When this method is employed, a temporary backer such as a 2 by 4 shall be provided to stiffen and hold the preformed metal joint in alignment ahead of the work and shall be removed as the work progresses.

3.06**CONTROL JOINTS**

- A. Control joints shall be aligned within the curb and gutter, sidewalk, and retaining walls (as applicable) at a maximum spacing of 10 linear feet. All components shall be similarly jointed. For sidewalks, control joint spacing shall be no longer than the width of the sidewalk.

B. Tooled Joint

1. Tooled joints shall be formed by scoring the slab the full depth with a steel trowel along a straight edge in locations as shown on the drawings or, if not shown, not to exceed 625 square feet in area.
2. The joint shall be finished using a joint tool guided by a straight edge leaving a slightly rounded edge on each side of the joint.

C. Sawn Joints

1. Sawn joints shall be sawn into interior concrete floors as indicated on the drawings and at Contractor's option in place of preformed metal keys.
2. Joints shall be sawn with a power saw designed to saw depth and width as shown on drawings. Handheld saws will not be accepted.
3. Saw cutting shall occur within 12 hours after placement of concrete. The line of the saw shall be straight, true to line, and square.
4. Pourable joint sealant shall be poured into all sawn joints. Installation shall be in strict accordance with manufacturer's specifications which shall include preparation, priming, etc.

3.07

JOINT SEALING

A. Surface Preparation

1. Remove oil, grease, wax, form-release-agents, curing compounds, bitumens, laitance, and old chalking material by sandblast, or water blast as recommended by manufacturer of sealant. Maximum sand blast angle, 25 degrees $\pm$ 5.
2. Clean and dry with air blast. Do not contaminate air blast with oils or lubricants.
3. Remove frost and moisture in concrete joint substrates before commencing sealing.

B. Installation

1. Ensure that sealants are installed in uniform, continuous ribbons without gaps or air pockets, with complete bonding of joint surfaces on opposite sides.
2. Except as otherwise indicated, fill sealant rabbet flush with surface.
3. Where horizontal joints are between a horizontal surface and vertical surface, fill joint to form a slight cove so that joint will not trap moisture and dirt.

- C. Depths: Saw cut joints if necessary to provide the required sealant thickness and depth. Install sealant to depths indicated or, if not indicated, as recommended by sealant manufacturer, but within the following general limitations measured at center (thin) section of bead:

1. For sidewalks, pavements, and similar joints sealed with elastomeric sealants and subject to traffic and other abrasion and indentation exposures, fill joints to a depth equal to 75 percent of joint width, but neither more than 5/8 inch deep nor less than 3/8 inch deep.
 2. For normal moving joints sealed with elastomeric sealants but not subject to traffic, fill joints to a depth equal to 50 percent of joint width, but neither more than 1/2 inch deep nor less than 1/4 inch deep.
 3. For joints sealed with non-elastomeric sealants and caulking compounds, fill joints to a depth in range of 75 percent to 125 percent of joint width.
- D. Spillage: Do not allow poured sealant compound to overflow or spill onto adjoining surfaces or to migrate into voids of adjoining surfaces. Clean adjoining surfaces to eliminate evidence of spillage.
- E. Heating: Do not overheat hot-applied sealants.
- F. Edges: Unless indicated otherwise, recess exposed edges of gasket and exposed joint fillers slightly behind adjoining surfaces so compressed units will not protrude from joints.

3.08 CURE AND PROTECTION

- A. Cure sealants and caulking compounds in accordance with manufacturer's instructions and recommendations to obtain high early bond strength, internal cohesive strength and surface durability.
- B. Follow procedures required for cure and protection of joint sealants during construction period so they will be without deterioration or damage (other than normal wear and weathering) at time of Substantial Completion.

3.09 CLEANING

- A. Clean off excess sealants or sealant smears adjacent to joints as work progresses. Use methods and cleaning materials approved by manufacturers of joint sealant and of products in which joints occur.
- B. Remove protective coating and oil from metals with solvent recommended by the sealant manufacturer.

3.10 PROTECTION

- A. Protect joint sealant during and after curing period from contact with contaminating substances or from damage resulting from deterioration or damage at time of Substantial Completion.
- B. If damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealant immediately and reseal joints with new materials to produce joint sealer

installations with repaired areas indistinguishable from original work at no additional cost to Owner.

PART 4 METHOD OF MEASUREMENT AND BASIS OF PAYMENT

4.01 METHOD OF MEASUREMENT

- A. Unless otherwise noted in the special provisions, no separate measurement will be made for items under this section.

4.02 BASIS OF PAYMENT

- A. Unless otherwise noted in the special provisions, no separate payment will be made for items under this section. Full compensation shall be considered as included in the prices paid for the various contract items and no additional compensation will be allowed.

END OF SECTION

SECTION 03304 — PORTLAND CEMENT CONCRETE

PART 1 GENERAL

1.01 SUMMARY

- A. Portland cement concrete material requirements.
- B. Mix design requirements.
- C. Method of measurement and basis of payment

1.02 DEFINITIONS

- A. Average Strength (fcr): The required average strength for 30 consecutive strength tests which statistically assures no more than the permissible proportions of tests will fall below Specified Strength.
- B. Specified Strength (fc'): The indicated strength.

1.03 REFERENCES

- A. AASHTO 26: Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete.
- B. ACI 211.1: Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete.
- C. ACI 211.2: Standard Practice for Selecting Proportions for Structural Lightweight Concrete.
- D. ACI 211.3: Standard Practice for Selecting Proportions for Non-Slump Concrete.
- E. ACI 214: Recommended Practice for Evaluation of Strength Test Results of Concrete.
- F. ACI 301: Specifications for Structural Concrete for Buildings.
- G. ASTM C33: Concrete Aggregates.
- H. ASTM C88: Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate.
- I. ASTM C94: Ready-Mix Concrete.
- J. ASTM C150: Portland Cement.
- K. ASTM C260: Air-Entraining Admixtures for Concrete.
- L. ASTM C289: Standard Test Method for Potential Reactivity of Aggregates (Chemical Method).
- M. ASTM C494: Chemical Admixtures for Concrete.

- N. ASTM C618: Fly Ash and Raw or Calcined Natural Pozzolan for use as a Mineral Admixture in Portland Cement Concrete.

1.04

SUBMITTALS

- A. Mix Design: Submit each proposed mix design 14 days prior to use in the Work. Indicate whether mixes have been designed for pumping. Include in the report the following information.
1. Water-cement ratio.
 2. Proportion of materials in the mix.
 3. Source and type of cement.
 4. Analysis of water to be used unless potable.
 5. Type and name of admixtures applied. Indicate when accelerating or retarding admixtures are to be used and the resulting change in placement times.
 6. Slump, air content, and temperature of samples.
 7. Unit weight of fresh and dry light weight concrete.
- B. Concrete Quality Charts. Comply with ACI 214 and ACI 301 and submit the following.
1. Specified strength (f'_c).
 2. Required average strength (f_{cr}).
 3. Compressive strength versus date of sample.
- C. Optional design mix:
1. At Contractor's option, he may elect to provide a concrete mix that has been previously designed, tested, and used and which provides the quality required by these Specifications.
 2. If Contractor exercises this option, he shall submit to Engineer for his approval all pertinent data, including test results to substantiate the design mix requested to be furnished.
- D. Aggregate Test Report: Submit for each aggregate source.
1. Date of test analysis.
 2. Sieve analysis.
 3. Organic impurities.
 4. Sodium sulfate soundness test.
 5. Reactivity of aggregate.

6. Complete identification of aggregate source of supply.

1.05 QUALITY ASSURANCE

- A. Do not change material sources, type of cement, air-entraining agent, water reducing agent, other admixtures, or aggregate without Engineer's approval.
- B. In proportioning materials for mixing, use scales certified by the State of Wyoming. Do not use volume measurement except for water and liquid admixtures.
- C. Do not change the quantity of cement per cubic yard from approved mix design without written approval of Engineer.
- D. Use of admixture will not relax hot or cold weather placement requirements.
- E. Ready-mixed concrete to be in accordance with Alternate No. 3 of ASTM C94 and requirements in this Section.
- F. Control Testing of Concrete: In Accordance with Section 03305, CONCRETE QUALITY CONTROL.

1.06 PRODUCT STORAGE AND HANDLING

- A. Store bagged and bulk cement in weatherproof enclosures to exclude moisture and contaminants.
- B. Stockpile aggregate to avoid segregation and prevent contamination.
- C. Avoid contamination, evaporation, or damage to admixtures. Protect liquid admixtures from freezing.

PART 2 PRODUCTS

2.01 CEMENT

- A. Portland Cement: ASTM C150, Modified Type II - Low Alkali, with tri-calcium aluminate ($3\text{CaO Al}_2\text{O}_3$) of not more than 5% or Type V - Low Alkali.
- B. Do not use air-entraining cement.

2.02 WATER

- A. Clean, potable and free from injurious amounts of foreign matter.
- B. Comply with AASHTO 26.

2.03 AGGREGATES - GENERAL

- A. Gravel, crushed slag, crushed stone, or other inert materials, composed of hard, strong, durable particles free of injurious coatings.
- B. The materials passing the No. 200 sieve shall not exceed 1.75 percent by weight in the combined coarse and fine aggregate.

2.04**COARSE AGGREGATE**

- A. Sieve Analysis: Graded in accordance with ASTM C33, as follows.

MASTER GRADING BAND LIMITS FOR COARSE AGGREGATION						
	COARSE AGGREGATE Percent Passing by Weight					
Sieve Sizes	Grade 467		Grade 57		Grade 67	
in	Min	Max	Min	Max	Min	Max
2"	100	-	-	-	-	-
1 ½"	95	100	100	-	-	-
1"	-	-	95	100	100	-
¾"	35	70	-	-	90	100
½"	-	-	25	60	-	-
⅜"	10	30	-	-	20	55
#4	0	5	0	10	0	10
#8	-	-	0	5	0	5

- B. Gradation limits may be changed if, in the judgment of Engineer, workability and methods of consolidation are such that concrete can be placed without honeycomb or voids, and the maximum aggregate size does not exceed the following requirements.

1. 1/5 of narrowest dimension between forms.
2. 1/3 of depth of slabs.
3. 3/4 of minimum clear spacing between reinforcing bars.

- C. Deleterious Substances: Maximum percentage by weight.

1. Clay Lumps: 0.5 percent.
2. Coal, Lignite, or Shale: 0.3percent
3. Material Passing #200 Sieve: 4.0 percent.
4. m of above materials and other deleterious materials shall not exceed 5.0 percent by weight.

2.05**FINE AGGREGATE**

- A. Sieve Analysis: Graded in accordance with ASTM C33, as follows.

MASTER GRADING BAND LIMITS FOR FINE AGGREGATION		
	FINE AGGREGATE Percent Passing by Weight	
Sieve Sizes	MIN	MAX
in		
⅜"	100	-
#4	95	100

#16	45	80
#50	10	30
#100	2	10

- B. Deleterious Substances: Maximum percentage by weight.
1. Clay Lump: 0.5 percent.
 2. Coal, Lignite, or Shale: 0.3 percent.
 3. Material Passing No. 200 Sieve: 4.0 percent.
 4. Sum of above materials and other deleterious materials shall not exceed 4.0 percent by weight.

2.06

ADMIXTURES

- A. Air Entrainment: ASTM C260.
- B. Water Reducing and Set Retarding Agents: ASTM C494.
1. Type A: Set water reducing.
 2. Type B: Set retarding.
 3. Type C: Set accelerating.
 4. Type D: Water reducing and set retarding.
 5. Type E: Water reducing and set accelerating.
 6. Type F: High range water reducing (super plasticizer). *
 7. Type G: High range water reducing and set retarding. *
- * - The relative durability factor of water reducing admixtures shall not be less than 80, and the chlorides content (as C1-) shall not exceed 1 percent by weight of the admixtures.
- C. Calcium Chloride: None allowed.
- D. Pozzolan: Pozzolan conforming to the requirements of ASTM C618, Class F, is allowed as a portland cement replacing agent under the following conditions:
1. The maximum percentage of portland cement replacement is:
 - a. 15 percent, for concrete exposed to weather.
 - b. 20 percent, for interior concrete.
 2. The ratio of replacement by weight of Pozzolan to cement shall be 1.25 to 1.0.
 3. The minimum cement content shall be used in the design formulas before replacement is made.

4. Loss of ignition of pozzolan is less than 3 percent, and the water requirement does not exceed 100 percent.
5. All other requirements of this Section still apply.
6. Mix designs including trial batches are required for each aggregate source and for each concrete class.

2.07

ACI MIX DESIGN

- A. The amount by which the average strength (f_{cr}) of a concrete mix exceeds the specified compressive strength (f'_c) shall be based upon no more than 1 in 100 random individual strength tests falling more than 500 psi (3.45 mPa) below the specific strength.
- B. Proportion the materials in accordance with ACI 211.1, 211.2, or 211.3 as applicable to produce concrete having the properties or limitations of the table below.

CONCRETE MIX PROPERTIES						
CONCRETE PROPERTIES	CONCRETE CLASSIFICATIONS					
	Class 7000	Class 6000	Class 5000	Class 4000	Class 3000 (f)	Class 2000 (f)
Specified Compressive Strength f'_c at 28 days, min., psi	7000	6000	5000	4000	3000	2000
Compressive Strength at 7 days, psi, min. (a)	4690	4020	3350	2680	2010	1430
Cement content (94-lb sacks of cement per Cubic yard of concrete), Min. (b)	(c)	(c)	(c)	6.0	5.5	4.5
Entrained air content, (%by column)	(d)	(d)	(d)	6 ± 1	6 ± 1 ± 1.5	4.5
Slump range, in. (e)	2 – 4	2 – 4	2 – 4	2 – 4	2 – 4	2 – 5

- (a) Used for monitoring purposes only.
- (b) Includes pozzolan replacements.
- (c) Cement content shall be appropriate to produce a mixture meeting the requirements for water/cement ratio and workability for the specific job conditions.
- (d) Air content shall be appropriate to the exposure conditions.
- (e) Not more than 8 inches after adding high range water reducing admixture (super-plasticizer) at site.
- (f) Not allowed if concrete is exposed to freezing and thawing temperatures. Use Class 4000 or higher compressive strength and 6 ± 1.0 percent air entrainment.

2.08

HAND MIXING

- A. Do not hand mix batches exceeding 0.5 cubic yards.

- B. Hand mix only on watertight platform. Mix cement and aggregate prior to adding water.
- C. Ensure all stones are thoroughly covered with mortar and mixture is of uniform color and consistency.

2.09 HEATING, WATER, AND AGGREGATE

- A. Do not allow products of fuel combustion to contact the aggregate.
- B. Heat mixing water to 150°F maximum. Heat aggregates uniformly.
- C. Do not mix cement with water and aggregate at a mix temperature greater than 100°F.

PART 3 EXECUTION

3.01 INSTALLATION

- A. CONCRETE WORK; Section 03310.
- B. CONCRETE QUALITY CONTROL; Section 03305.
- C. CONCRETE CURING; Section 03370.

PART 4 METHOD OF MEASUREMENT AND BASIS OF PAYMENT

4.01 METHOD OF MEASUREMENT

- A. Concrete will be measured by the cubic yard to the nearest one-tenth cubic yard in accordance with the dimensions shown on the plans or ordered. Volumes occupied by reinforcing steel, anchors, or expansion devices, conduits, weep holes, structural steel, pre-cast, pre-stressed concrete girders, or steel piling will not be deducted from the concrete volume. Eye bolts required for box culverts and bridges to attach fencing, as shown on the plans, shall be considered subsidiary to other contract items.
- B. Where Engineer determines that it is impracticable to determine the volume of concrete by the dimension method, concrete will be measured by batch volumes incorporated into the Work. When batch measurement is used, an inspector will observe the weight of materials batched, and the weight will be converted to volume in accordance with the design mix.

4.02 BASIS OF PAYMENT

- A. The accepted quantities of structural concrete will be paid for at the contract unit price per cubic yard complete in place.
- B. Payment will be made under the specific type or class of concrete, and the pay unit shall be by the cubic yard basis.

END OF SECTION

SECTION 03305 — CONCRETE QUALITY CONTROL

PART 1 GENERAL

1.01 SUMMARY

- A. Testing requirements for Contractor's quality control of portland cement concrete mixtures.
- B. Re-testing potentially defective concrete.

1.02 REFERENCES

- A. ACI Code 318: Building Code Requirements for Structural Concrete.
- B. ASTM C31: Standard Test Practice for Making and Curing Concrete Test Specimens in the Field.
- C. ASTM C39: Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
- D. ASTM C42: Standard Method of Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
- E. ASTM C78: Standard Test Method for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading).
- F. ASTM C138: Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete.
- G. ASTM C172: Standard Method of Sampling Freshly Mixed Concrete.
- H. ASTM C173: Standard Test Method for Air Content of Freshly Mixed Concrete by Volumetric Method.
- I. ASTM C231: Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
- J. ASTM C567: Standard Test Method for Determining Density of Structural Lightweight Concrete.
- K. ASTM D4832: Standard Test Method for Preparation and Testing of Controlled Low Strength Material (CLSM) Test Cylinders.

1.03 SUBMITTALS

- A. Field and laboratory control test reports for material properties enumerated herein.
- B. Material certificates.

1.04 QUALITY ASSURANCE

- A. Test Forms and Storage Areas: ASTM C31.

- B. Control testing in accordance with Section 01440, SUBMITTALS.

1.05 PROJECT CONDITIONS

- A. Furnish labor to assist in obtaining and handling samples at site or sources.
- B. As a result of failed tests, perform remedial Work at no additional cost to Owner.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 TESTING COMPRESSION STRENGTH

- A. Obtaining Samples: Unless indicated otherwise, secure composite samples in accordance with ASTM C172. Obtain samples from different portions of the batch of concrete.
- B. Casting:
 - 1. Cast and cure four concrete cylinders in accordance with ASTM C31, three for testing and one to be cured as a spare. Determine unit weight, slump, air content, and temperature of concrete casting.
 - 2. For controlled low-strength material (CLSM) and lime treated fills, cast concrete cylinders in accordance with ASTM D4832.
- C. Testing: Perform compression tests on samples in accordance with ASTM C39.
 - 1. Two specimens shall be tested at 28 days for acceptance, and one shall be tested at 7 days for information. The acceptance test results shall be the average of the strengths of the two specimens tested at 28 days. If one specimen in a test manifests evidence of improper sampling, molding or testing, it shall be discarded and the spare specimen shall be tested and averaged as one of the two constituting the 28 day test.
 - 2. For CLSM and lime treated fills, test one cylinder at 3 days and the remainder at 28 days.
 - 3. If any one cylinder in a 28-day test shows definite evidence, other than low strength, of improper sampling, molding, handling, curing, or testing, discard. The average strength of the remaining cylinders shall be considered the test result.

3.02 TESTING FLEXURAL STRENGTH

- A. Obtaining Samples: Secure composite samples in accordance with ASTM C172. Obtain samples from different portions of the batch of concrete.
- B. Casting: Cast and cure four concrete beams in accordance with ASTM C31. Determine slump, air content, and temperature of concrete casting. Report deviations from requirements.

- C. Testing: Perform flexural tests on samples; ASTM C78.
 - 1. Test one beam at 7 days or as approved by Engineer for determining when construction traffic is permitted on paved surfaces.
 - 2. Test the remaining beams at 28 days. If any one beam in a 28-day test shows definite evidence, other than low strength, of improper sampling, molding, handling, curing, or testing, discard. The average strength of the remaining beams shall be considered the test results.

3.03 TESTING CONCRETE PAVEMENT THICKNESS

- A. Determined from cores secured in accordance with ASTM C42.

3.04 TESTING CONCRETE PAVING SMOOTHNESS

- A. Maximum perpendicular distance between 3 straightedge points and the pavement surface:
 - 1. Parallel to Centerline: 1/8 inch to 10 feet.
 - 2. Perpendicular to Centerline: 1/4 inch to 10 feet.

3.05 ADDITIONAL TESTING

- A. Slump Test: ASTM C231.
- B. Air Test:
 - 1. Normal weight concrete air content; ASTM C231.
 - 2. Light weight concrete air content; ASTM C173.
- C. Unit Weight:
 - 1. Normal weight concrete; ASTM C138.
 - 2. Light weight concrete; ASTM C567.
- D. When requested, test concrete in place by impact hammer, sonoscope, or other non-destructive device:
 - 1. To determine relative strengths in various locations in Work.
 - 2. To aid in evaluating concrete strength.
 - 3. To select areas to be cored.
 - 4. To verify quality control in the absence of Control Testing.

3.06 RE-TESTING POTENTIALLY DEFECTIVE CONCRETE

- A. If a concrete test result is below specification and the Work is considered potentially deficient:

1. A request to Engineer for re-testing must be made within 35 days from time of placement if Contractor desires re-test.
 2. No coring or re-testing shall be done after 40 days have elapsed from the time of placement.
 3. Only one re-test shall be allowed for a test subplot.
- B. Obtain and test cores in accordance with ASTM C42. Secure a minimum of three cores from each subplot considered potentially deficient. Coordinate test locations with Engineer.
- C. If concrete in Work will be dry under service condition, air dry cores for 7 days before tests. Unless otherwise specified, use air temperature 60° to 80°F and relative humidity less than 60 percent.
- D. If concrete in Work under service conditions will be more than superficially wet, test cores after moisture conditioning (liquid or vapor water cure).
- E. If one or more cores show evidence of having been damaged before testing, provide replacement.
- F. Evaluate cores in accordance with ACI 318.
- G. If core tests are inconclusive or impractical to obtain, or if structural analysis does not confirm the safety of the Work, load test may be required and evaluated in accordance with ACI 318.
- H. Fill core holes with non-shrink, low slump concrete mortar. Coat sides of holes with an approved concrete epoxy resin adhesive. Match color and texture of surrounding concrete.

PART 4 METHOD OF MEASUREMENT AND BASIS OF PAYMENT

4.01 METHOD OF MEASUREMENT

- A. Measurement will be made only if additional testing and analysis are required if the tests show deficiencies. Measurement will be based on the independent lab units of measurement.

4.02 BASIS OF PAYMENT

- A. Pay all costs incurred in providing additional testing and analysis required if the tests show deficiencies. If additional testing shows concrete meets specification, Owner will pay for additional testing.

END OF SECTION

SECTION 03310 — CONCRETE WORK

PART 1 GENERAL

1.01 SUMMARY

- A. Concrete placement operations for cast-in-place slabs on grade, slabs on fill, structural building frame, and other concrete components.

1.02 REFERENCES

- A. ACI 301: Specifications for Structural Concrete
- B. ACI SPEC-305.1: Specification for Hot Weather Concreting
- C. ACI SPEC 306.1: Cold Weather Concreting
- D. ACI PRC-309-05: Guide for Consolidation of Concrete

1.03 SUBMITTALS

- A. Quality control test reports and material certificates; Section 03305, CONCRETE QUALITY CONTROL.
- B. Record of Placed Concrete: Record date, location of pour, quantity, air temperature, and Contractor's quality control test samples taken.
- C. Product name, type, and chemical analysis of the following as applicable:
 - 1. Curing compound.
 - 2. Sealing compound.
 - 3. Chemical hardener.
 - 4. Bonding compound.
- D. Batch Delivery Ticket: Submit for each batch delivered to site.
 - 1. Slump of batch at the job site.
 - 2. Date.
 - 3. Producer and plant.
 - 4. Job.
 - 5. Name of contractor.
 - 6. Serial number of ticket.
 - 7. Truck number and time dispatched.
 - 8. Volume of concrete.

9. Reading of revolution counter at first addition of water.
10. Signature or initials of Ready-Mix representative.
11. Type and brand of cement.
12. Amount of cement.
13. Total water content (W/C ratio).
14. Water added for receiver of concrete and receiver's initials.
15. Admixture types and amounts.
16. Maximum size of aggregate.
17. Separate weights of fine and coarse aggregate.
18. Indication that all ingredients are as previously certified or approved.

1.04

QUALITY ASSURANCE

- A. Rejection: Concrete Work which fails to meet one or more of the following requirements and which cannot be brought into compliance shall be rejected. Engineer shall determine appropriate modifications or payment adjustments to be made.
 1. Appearance: Concrete exposed to view with defects which adversely affect appearance of specified finish.
 2. Strength: Strength of concrete fails to comply with any of the following requirements.
 - a. The average of three 28-day compressive or flexural strength samples made from the same batch of concrete falls below the acceptance level.
 - b. Reinforcing steel size, quantity, strength, position, damage, or arrangement at variance with requirements.
 - c. Concrete which differs from required dimensions or location in such a manner as to reduce its strength or load carrying capacity.
 - d. Method of curing is not as specified.
 - e. Inadequate protection of concrete from extremes of temperature during the early stages of hardening and strength development.
 - f. Mechanical injury, construction fires, accidents, or premature removal of formwork likely to result in deficient strength development.
 - g. Workmanship likely to result in deficient strength.
 3. Slab Tolerance: Finishing which fails to comply with Section 03345, CONCRETE FINISHING, requirement.

4. Material Sources: Failure to comply with Section 03305, CONCRETE QUALITY CONTROL.

B. Finishers: Approved by Engineer or ACI certified.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Concrete: Class as indicated, material in accordance with Section 03304, PORTLAND CEMENT CONCRETE.
- B. Bonding Compound: Polyvinyl acetate base or acrylic base, of the type that cannot be re-hydrated.
- C. Vapor Barrier: 10-mil-thick, clear, polyethylene sheet. Type recommended for below grade application and shall be free from pin holes, tears, scars, and other defects.
- D. Forms: In accordance with Section 03100, CONCRETE FRAMEWORK.
- E. Reinforcement: In accordance with Section 03200, CONCRETE REINFORCEMENT.
- F. Coverings and Curing Compound: In accordance with Section 03370, CONCRETE CURING.
- G. Non-shrink Grout: Adhesives epoxy, in accordance with Section 03600, GROUT.

PART 3 EXECUTION

3.01 PREPARATION

- A. Verify that anchors, seats, plates, reinforcement, and other items to be cast into concrete are accurately placed, held securely, and will not impede placing concrete.
- B. Do not allow construction loads to exceed member capacity.
- C. Prepare previously placed concrete by cleaning with steel brush and applying bonding compound. Apply bonding compound in accordance with manufacturer's instructions.
- D. At locations where new concrete is dowelled to existing Work, drill holes in existing concrete, insert steel dowels, and pack solid with non-shrink grout.

3.02 DELIVERY

- A. Slump: Do not discharge concrete if its slump is greater or less than permissible slump. Report results of slump test on batch delivery tickets.
- B. Concrete Placement Time Limit: After the introduction of mixing water to the cement and aggregates at the batch plant, discharge concrete from truck mixer within the following air temperatures and time periods.
 1. Air temperature less than 80°F: 1-1/2 hours.

2. Air temperature over 80°F without a retarder added to the mix: 1 hour maximum.
 3. Air temperature over 80°F with retarder added to the mix: 1-1/2 hours maximum.
- C. Tempering
1. When concrete arrives at site with slump below specified, water may be added if the maximum approved water/cement ratio and the maximum slump is not exceeded, provided that:
 - a. The approved mix design has allowed for on-site addition of water.
 - b. The amount of water added at the site is accurately measured to ± 1 gallon of the desired added amount.
 - c. That water addition is followed by 3 minutes of mixing at mixing speed prior to discharge.
 - d. That the person authorized to add water is mutually approved of in writing by Engineer, Contractor, and Ready-Mix Supplier.
 2. Do not add water after concrete discharge from the mixer commences.
- D. Cold Weather, Hot Weather Concreting: Maintain mixed concrete temperature at times of placement between 60°F and 90°F.
- E. Super-plasticizer
1. Pre-measure and add high range water reducing agent in accordance with manufacturer's instructions.
 2. If added at site, add agent using injection equipment capable of rapidly and uniformly distributing the admixture to the concrete. Prior to discharge, mix for a minimum of 5 minutes at a drum rate not less than 12 RPM or more than 15 RPM.
 3. If added at plant, do not deliver to site unless batch delivery ticket displays water/cement ratio prior to super-plasticizer addition.
 4. Tempering with super-plasticizer after expiration of allowable delivery times is prohibited.

3.03

CONCRETE PLACEMENT

- A. Notify Engineer minimum 24 hours prior to commencement of concrete placement operations.
- B. Place concrete in accordance with ACI 301.
- C. Hot Weather Placement: When hot weather conditions exist that would seriously impair the quality and strength of concrete, place concrete in compliance with ACI 305 and as herein specified.

1. Cool ingredients before mixing to maintain concrete temperature at time of placement below 90°F Mixing water may be chilled, or chopped ice may be used to control the concrete temperature, provided the water equivalent of the ice is calculated to the total amount of mixing water.
2. Cover reinforcing steel with water-soaked burlap if it becomes too hot so that the steel temperature will not exceed the ambient air temperature immediately before embedment in concrete.
3. Wet forms thoroughly before placing concrete.

D. Cold Weather Placement

1. Protect concrete work from physical damage or reduced strength, which could be caused by frost, freezing actions, or low temperatures, in compliance with ACI 306 and as herein specified. If necessary to place concrete under conditions of low temperature, placement shall be approved by Engineer.
2. When air temperature has fallen to or is expected to fall below 40°F, uniformly heat all water and aggregates before mixing, as required to obtain a concrete mixture temperature of not less than 50°F and not more than 70°F for 3 days or 50°F for 5 days.
3. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen material.
4. Do not use calcium chloride, salt and other material containing antifreeze agents, or chemical accelerators, unless otherwise accepted in writing by Engineer.

E. Do not disturb reinforcement, inserts, embedded parts, and formed joints.

F. Do not break or interrupt successive pours such that cold joints occur.

G. Honeycomb or embedded debris in concrete is not acceptable.

3.04 JOINTS AND JOINT SEALING

- A. Expansion and contraction joints, in accordance with Section 03251, EXPANSION AND CONTRACTION JOINTS.

3.05 CONSOLIDATION

- A. In accordance with ACI 309.
- B. Keep spare vibrator available during concrete placement operations.

3.06 FINISHING

- A. Do not add water to concrete surface (i.e., sprinkle) without written approval.
- B. Slab Finishing Tolerance: In accordance with Section 03345, CONCRETE FINISHING.

- C. Finishes: In accordance with Section 03345, CONCRETE FINISHING. When type of finish is not indicated, use following finishes as applicable:
1. Sidewalks, garage floors, and ramps: Broom or belt finish.
 2. Exterior concrete pavement: Broom or belt finish.
 3. Exterior platforms, steps, and landings, exterior and interior pedestrian ramps, not covered by other finish materials: Non-slip finish.
 4. Surfaces intended to receive bonded applied cementitious applications: Scratched finish.
 5. Surfaces intended to receive roofing, except future floors, waterproofing membranes, and roof surfaces which are future floors or sand bed terrazzo: Floated finish.
 6. Floors and roof surfaces which are floors intended as walking surfaces or to receive floor coverings: Troweled finish.
 7. Unpainted concrete surfaces not exposed to public view: Rough as-cast form finish.
 8. Unpainted concrete surfaces exposed to public view: Smooth as-cast form finish.
 9. Concrete surfaces to receive paint or plaster: Grout cleaned finish.

3.07 CURING

- A. Cure in accordance with Section 03370, CONCRETE CURING. Unless specified otherwise, apply a liquid membrane curing compound.

3.08 CONTROL TESTING

- A. Arrange for and perform all control testing required for qualification of proposed materials and the establishment of mix designs, in determining strengths for early form removal and other needs of Contractor.
- B. One slump test for each batch of concrete placed in the Work.
- C. Two slump tests, one before and one after the addition of super-plasticizer.

3.09 DEFECTIVE CONCRETE

- A. Modify or replace concrete not conforming to required levels, lines, details, and elevations.
- B. Structural analysis and additional testing may be required at no additional cost of Owner when the strength of a structure is considered potentially deficient.
- C. Patch imperfection. Refer to Section 03345, CONCRETE FINISHING, requirements.

3.10 PROTECTION AND REPAIRS

- A. Protection: Immediately after placement, protect concrete from premature drying, excessively hot or cold temperatures, and mechanical injury.
- B. Maintain concrete with minimum moisture loss at relatively constant temperature for period necessary for hydration of cement and hardening of concrete.
- C. Random Cracks in Pavement Slabs on Grade: When cracks occur within 2 feet of expansion or construction joints, remove and repair. Otherwise, grout with Section 03600, GROUT, epoxy adhesive grout. Use saw cuts and dowels in all cut planes.

PART 4 METHOD OF MEASUREMENT AND BASIS OF PAYMENT**4.01 METHOD OF MEASUREMENT**

- A. Measurement of this item shall be of the number of cubic yards placed for each concrete structural unit or category individually identified in the Bid Schedule.

4.02 BASIS OF PAYMENT

- A. Payment for concrete work shall be based on the unit price bid for each individual concrete category multiplied by the number of units (cubic yards) placed and measured as above.

END OF SECTION

SECTION 03345 — CONCRETE FINISHING

PART 1 GENERAL

1.01 SUMMARY

- A. Finishing interior and exterior concrete surfaces.

1.02 REFERENCES

- A. ACI 303: Guide to Cast-in-Place Architectural Concrete Practice.

1.03 SUBMITTALS

- A. Name, type, chemical analysis and manufacturer's recommended rate of application for liquid chemical hardener.

1.04 PROJECT CONDITIONS

- A. Protect adjacent materials and finishes from dust, dirt, and other surface or physical damage during finishing operations. Provide protections as required and remove from site at completion of Work.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Mortar and Grout: In accordance with Section 03600.
- B. Dry Shake: Blend of metallic or mineral aggregate with portland cement concrete in proportions recommended by manufacturer.
- C. Proprietary Materials: If permitted or required, proprietary compounds may be used in lieu of or in addition to foregoing materials. Use such compounds in accordance with manufacturer's recommendations.
- D. Liquid-Chemical Hardener: Colorless, aqueous solution containing a blend of magnesium fluosilicate, zinc fluosilicate, and a wetting agent. Mixture contains not less than 2 pounds fluosilicate per gallon and does not interfere with adhesives and bonding of finishes where such is indicated.

PART 3 EXECUTION

3.01 PREPARATION

- A. Examine the areas and conditions under which Work of this Section will be performed.
- B. Correct conditions detrimental to timely and proper finishing.
- C. Do not proceed until unsatisfactory conditions are corrected.

A. General

1. Allow concrete to cure not more than 72 hours before commencing surface finish operations, unless approved otherwise.
2. Revise the finishes as needed to secure approval.

B. As-Cast Form Finish

1. Rough: Patch defects and chip or rub off fins exceeding 1/4 inch height.
2. Smooth: Patch tie holes and defects and remove fins completely.
 - a. When surface texture is impaired and form joints misaligned, grind, bush hammer, or correct affected concrete.
 - b. Slurry grout areas evidencing minor mortar leakage to match adjacent concrete.
 - c. Repair major mortar leakage as a defective area.
 - d. When workmanship is less than acceptable standard, provide one of rubbed finishes at no additional cost to Owner.

C. Rubbed Finish

1. Smooth Rubbed: Remove forms and perform necessary patching as soon after placement as possible.
 - a. Finish newly hardened concrete no later than 24 hours following form removal.
 - b. Wet surfaces and rub with carborundum brick or other abrasive until uniform color and texture are produced.
2. Grout Cleaned: Undertake no cleaning operations until all contiguous surfaces are completed and accessible.
 - a. Wet surface of concrete sufficiently to prevent absorption of water from grout.
 - b. Apply grout uniformly.
 - c. Immediately after grouting, scrub surface with cork float or stone to coat surface and fill voids.
 - d. While grout is still plastic, remove excess grout by working surface with rubber float or sack.
 - e. After surface whitens from drying, rub vigorously with clean burlap.
 - f. Keep damp for at least 36 hours after final rubbing.

3. Cork Floated: Remove forms within 2 to 3 days of placement where possible.
 - a. Remove ties.
 - b. Remove all burrs and fins.
 - c. Dampen wall surface.
 - d. Apply mortar with firm rubber float or with trowel, filling all surface voids.
 - e. Compress mortar into voids.
 - f. If mortar surface dries too rapidly to permit proper compaction and finishing, apply a small amount of water with fog sprayer.
 - g. Produce final texture with cork float using a swirling motion.

D. Unformed Finish

1. After concrete is placed, strike smooth, tops of walls or buttresses, horizontal offsets, and similar unformed surfaces occurring adjacent to formed surfaces.
2. Float to texture which is reasonably consistent with formed surfaces.
3. Continue final treatment on formed surfaces uniformly across unformed surfaces.

E. Blasted Finish

1. Perform abrasive blasting within 24 to 72 hours after casting.
2. Coordinate with form work construction, concrete placement schedule, and form work removal to ensure that surfaces are blasted at the same age for uniform results.
3. Re-apply curing protection after blast finishing.

F. Architectural Finish

1. General: In accordance with ACI 303.
2. Tooled Finish:
 - a. Dress thoroughly cured concrete surface with electric, air, or hand tools to uniform texture, and give a bush hammered surface texture.
 - b. Remove sufficient mortar to exposed coarse aggregate in relief and to fracture coarse aggregate for tooled finish.

G. Patched Finish

1. Repair defective areas.
 - a. Remove honeycomb and defective concrete to sound concrete.

- b. Make edges perpendicular to surface or slightly undercut.
 - c. Feathered edges are not permitted.
 - d. Dampen area to be patched and at least 6 inches surrounding it to prevent absorption of patching mortar water.
 - e. Prepare bonding grout.
 - f. Mix to consistency of thick cream.
 - g. Brush into surface.
2. Tie Holes: Unless indicated otherwise, after being cleaned and thoroughly dampened, fill tie holes solid with patching mortar.
 3. Make any patches in concrete to closely match color and texture of surrounding surfaces. Determine mix formula for patching mortar by trial and obtain a good color match with concrete when both patch and concrete are cured and dry.
 - a. Mix white and gray portland cement as required to match surrounding concrete to produce grout having consistency of thick paint.
 - b. Use a minimum amount of mixing water.
 - c. Mix patching mortar in advance and allow to stand without frequent manipulation, without addition of water, until it has reached the stiffest consistency at which it can still be placed.
 - d. After initial set, dress surfaces of patches manually to obtain same texture as surrounding surfaces.
 4. After surface water has evaporated from patch area, brush bond coat into surface.
 - a. When bond coat begins to lose water sheen, apply patching mortar.
 - b. Thoroughly consolidate mortar into place and strike-off to leave patch slightly higher than surrounding surface.
 - c. Leave undisturbed for at least 1 hour before final finish.
 - d. Keep patched area damp for 72 hours or apply curing compound.
 - e. Do not use metal tools in finishing an exposed patch.
 5. Where as-cast finishes are indicated, total patched area may not exceed 1 in 500 of as-cast surface. This is in addition to form tie patches, if ties are permitted to fall within as-cast areas.
 6. In any finishing process which is intended to expose aggregate on surface, patched areas must show aggregate.
 - a. Outer 1 inch of patch shall contain same aggregates as surrounding concrete.

- b. For aggregate transfer finish, patching mixture shall contain same selected colored aggregates.
- c. After curing, expose aggregates together with aggregates of adjoining surfaces by same process.

3.03

FINISHING SLABS

- A. Slab Finishing Tolerances:
 - 1. Class A finish: 1 in 1000.
 - 2. Class B finish: 1 in 500.
 - 3. Class C finish: 1 in 250.
- B. Broom and Belt Finish: After concrete has been placed, consolidated, struck-off, and leveled to the required tolerance, roughen surface transversely with stiff brushes, rakes, or burlap belt before final set.
- C. Floated Finish: After concrete has been placed, consolidated, struck-off, and leveled, do not work further until ready for floating.
 - 1. Begin floating when water sheen has disappeared, and surface has stiffness sufficient to permit operation.
 - 2. During or after first floating, check planeness of entire surface with a 10-foot-long straightedge applied at 2 or more different angles.
 - 3. Cut down high spots and fill low spots to the required tolerance.
 - 4. Re-float slab immediately to a uniform sandy texture.
- D. Trowel Finish
 - 1. Float finish surface.
 - 2. Power trowel.
 - 3. Hand trowel as required to provide surface. Do not apply water (i.e., sprinkle) to surface of concrete in finishing operations.
 - 4. First troweling after power floating shall produce smooth surface relatively free of defects but which may still show some trowel marks.
 - 5. Second trowel by hand after surface has hardened.
 - 6. Leave finished surface essentially free of trowel marks, uniform in texture and appearance.
 - 7. On surfaces intended to support floor coverings, grind off defects which would show through floor coverings.

- E. "Dry Shake" Finish: Give surface a floated finish.
 - 1. Apply approximately 2/3 of a blended material for required coverage to surface by a method that ensures even coverage without segregation.
 - 2. Begin floating immediately after application of first "dry shake".
 - 3. After material has been embedded by floating, apply remainder of blended material to surface at right angles to prevent application.
 - 4. Make second application heavier in any areas not sufficiently covered by first application.
 - 5. Immediately follow with second floating.
 - 6. After selected material has been embedded by second floating, complete operation with a broomed, floated, or troweled finish, as indicated.
- F. Non-slip Finish: Give surface a "dry shake" application, using crushed, ceramic-bonded, aluminum oxide particles. Apply at 25 pounds per 100 square feet.
- G. Exposed Aggregate Finish: Immediately after surface of concrete has been leveled to tolerance and surface water has dissipated, spread aggregate uniformly over surface to provide complete coverage to the depth of a single stone.
 - 1. Embed aggregate into surface by light tamping.
 - 2. Float surface until embedded aggregate is fully coated with mortar and surface has been brought to tolerance.
 - 3. Start exposure of aggregate after matrix has hardened sufficiently to prevent dislodgment.
 - 4. Flow ample quantities of water, without force, over surface of concrete while matrix encasing aggregate is removed by brushing with a fine bristle brush.
 - 5. Continue until aggregate is uniformly exposed.
 - 6. An approved chemical retarder sprayed onto freshly floated surface may be used to extend working time.
- H. Chemical-Hardener Finish: Apply liquid chemical-hardener finish to interior concrete floors where indicated. Do not apply liquid chemical concrete hardener on floor areas scheduled to receive synthetic matrix terrazzo, setting beds for tile, terrazzo, vinyl flooring, or like items. Apply hardener after complete curing and drying of concrete surface in accordance with manufacturer's recommendations. Evenly apply each coat, and allow 24 hours for drying between coats. After final coat of chemical-hardener solution is applied and dried, remove surplus hardener by scrubbing and mopping with water.

PART 4 METHOD OF MEASUREMENT

4.01 METHOD OF MEASUREMENT (THIS WORK WILL NOT BE MEASURED FOR PAYMENT)

- A. Unless otherwise noted in the special provisions, no separate measurement will be made for items under this section. Full compensation shall be considered as included in the prices paid for the various contract items and no additional compensation will be allowed.

4.02 BASIS OF PAYMENT

- A. Unless otherwise noted in the special provisions, no separate payment will be made for items under this section. Full compensation shall be considered as included in the prices paid for the various contract items and no additional compensation will be allowed.

END OF SECTION

SECTION 03370 — CONCRETE CURING

PART 1 GENERAL

1.01 SUMMARY

- A. Concrete curing material requirements and methods.

1.02 REFERENCES

- A. ACI 301: Specifications for Structural Concrete for Buildings.
- B. ASTM C171: Sheet Materials for Curing Concrete.
- C. ASTM C309: Liquid Membrane-Forming Compounds for Curing Concrete.
- D. ASTM C642: Standard Test Method for Specific Gravity, Absorption, and Voids in Hardened Concrete.

1.03 SUBMITTALS

- A. Manufacturer's specifications, test data, and other data required to prove compliance with the specified requirements.
- B. Manufacturer's recommended installation procedures which, when approved by Engineer, will become the basis for accepting or rejecting actual installation procedures used in the Work.

1.04 QUALITY ASSURANCE

- A. Use workers who are trained, experienced, and completely familiar with the curing and protection requirements of ACI 301 and the specified requirements and the methods needed for proper performance of the Work of this Section.
- B. Maintain concrete with minimum moisture loss at relatively constant temperature recommended by manufacturer for a period necessary for hydration of cement and hardening of concrete.

1.05 PRODUCT HANDLING

- A. Protect the materials of this Section before, during, and after installation, and protect the Work and materials of other trades.
- B. In the event of damage, immediately make replacements and repair at no additional cost to Owner.

PART 2 PRODUCTS

2.01 WATER

- A. Clean, non-straining and non-detrimental.

2.02 MOISTURE-RETAINING SHEET MATERIALS

- A. ASTM C171, white, waterproof paper, polyethylene film, or burlap-polyethylene sheet.

2.03 ABSORPTIVE MAT MOISTURE COVER

- A. Cotton or burlap fabrics, clean roll goods.

2.04 CURING COMPOUND

- A. Liquid membrane, in accordance with ASTM C309.
- B. Substance type: Unless indicated, Contractor to select from the following:
 - 1. Chlorinated rubber.
 - a. Type of Compound: Type 2, white pigmented (Titanium Oxide (TiO₂), 7 to 9 percent by weight of total solids.
 - b. Vehicle Solids Material: Class B, restricted to all resin materials. 40 percent minimum by weight of total solids remainder of vehicles solids to chlorinated paraffin.
 - c. Total Solids: 25 percent minimum by weight of compounds.
 - d. Viscosity: 20 seconds maximum (Ford Cup).
 - e. Fineness of Grand: 6 minimum.
 - f. Drying Time:
 - 1) Set to Touch: 20 minutes maximum.
 - 2) Dry Hard: 45 minutes.
 - 3) Alkali Resistance: 48 hours minimum.
 - g. Salt Spray (5 percent @ 95°F (35° C)): 500 hours minimum.
 - 2. Sodium silicate.
 - a. Type of Compound: Type 2, white pigmented.
 - b. Vehicle Solids Material: Class A, no restriction.
 - 3. Poly-siloxane (alkyl-alkoxy siloxane).
 - a. Type of Compound: Type 1, clear or translucent without dye.
 - b. Vehicle Solids Material: Class B, restricted to all resin materials.
- C. Water Solubility: Less than 1 percent.

- D. Weight Gain: At least 85 percent reduction of water absorption during initial 24 hour curing period when compared to untreated test sample, ASTM C642.
- E. Scaling Resistance: Weight loss less than 2.0 percent when subject to 500 cycles of freeze-thaw.

PART 3 EXECUTION

3.01 INSPECTION

- A. Verify concrete surfaces are ready for curing. Correct conditions detrimental to timely and proper completion of the Work. Do not proceed until unsatisfactory conditions are corrected.

3.02 PREPARATION

- A. Prepare the surface in strict accordance with manufacturer's recommendations.

3.03 MOISTURE COVER CURING

- A. Apply one or both of the following methods.
 - 1. Water or continuous water-fog spray.
 - 2. Cover concrete surface with absorptive mat, thoroughly saturate with water, and keep continuously wet.
- B. Place absorptive mat to provide coverage of concrete surfaces and edges. Lap over adjacent absorptive covers.

3.04 MOISTURE-RETAINING SHEET CURING

- A. Place cover in widest practicable width with sides and ends lapped and sealed to prevent moisture loss.
- B. Repair any holes or tears during curing period.

3.05 FORMED SURFACE CURING

- A. Cure formed concrete surface, including undersides of beams, supported slabs, and other similar surfaces by moist curing with forms in place for full curing period or until forms are removed.
- B. If forms are removed, continue curing by curing compound or methods indicated above, as applicable.

3.06 UNFORMED SURFACE CURING

- A. Cure unformed surfaces, such as slabs, floor toppings, and other surfaces by application of appropriate curing method.
- B. Final cure concrete surfaces to receive liquid floor hardener or finish flooring by use of moisture-retaining cover, unless approved otherwise.

3.07 CURING COMPOUNDS

- A. Apply the approved product to the designated surfaces in strict accordance with the manufacturer's recommended application procedures.
- B. Apply immediately following the final finishing operation as soon as the concrete is firm enough to work on.
- C. Apply uniformly in continuous operation.
- D. Maintain continuity of coating and repair damage during cure period.
- E. Should side forms be removed before expiration of cure period, coat exposed surface with curing compound.
- F. Unless specified otherwise by manufacturer of curing compound, do not use curing compound on surfaces which are to be covered with coating materials.

3.08 SCHEDULE OF CURING APPLICATIONS

- A. Concrete Exposed to Potable Water (as in Water Storage Reservoirs): Moisture cover curing.

PART 4 METHOD OF MEASUREMENT AND BASIS OF PAYMENT

4.01 METHOD OF MEASUREMENT (THIS WORK WILL NOT BE MEASURED FOR PAYMENT)

- A. Unless otherwise noted in the special provisions, no separate measurement will be made for items under this section. Full compensation shall be considered as included in the prices paid for the various contract items and no additional compensation will be allowed.

4.02 BASIS OF PAYMENT

- A. Unless otherwise noted in the special provisions, no separate payment will be made for items under this section. Full compensation shall be considered as included in the prices paid for the various contract items and no additional compensation will be allowed.

END OF SECTION

SECTION 03480 — PRECAST CONCRETE UNITS

PART 1 GENERAL

1.01 SUMMARY

- A. Precast concrete units, complete with required connecting and supporting devices.

1.02 REFERENCES

- A. ACI 318: Building Code Requirements for Structural Concrete. This reference standard includes other ASTM material standards.
- B. ASTM A36: Carbon Structural Steel.
- C. ASTM C478: Circular Precast Reinforced Concrete Manhole Sections.
- D. ASTM C858: Underground Precast Concrete Utility Structures.
- E. American Welding Society (AWS) D1.1: Structural Welding - Steel.
- F. AWS D1.4: Structural Welding Code - Reinforcing Steel.
- G. Precast/Prestressed Concrete Institute (PCI) Design Handbook
- H. PCI MNL-116: Quality Control for Plants and Production of Structural Precast Concrete Products.
- I. PCI MNL-117: Quality Control for Plants and Production of Architectural Precast Concrete Products.

1.03 SUBMITTALS

- A. Prepare Shop Drawings under seal of Professional Engineer.
- B. Submit Shop Drawings in accordance with Section 01340.
- C. Indicate unit locations, unit identification marks, fabrication details, reinforcement, connection details, pertinent dimensions, and erection support points. Unit identification marks to appear on all manufactured units.
- D. Do not proceed with fabrication until Shop Drawings have been accepted.

1.04 QUALITY ASSURANCE

- A. Design precast concrete units in accordance with ACI 318 and PCI design handbook.
- B. Under direct supervision of Professional Engineer who is fully experienced in design of units.
- C. Design units to support required stripping and handling loads, live, dead, and construction loads.

- D. Design component connections to provide adjustment to accommodate misalignment of structure during installation.

1.05 MANUFACTURER AND ERECTOR QUALIFICATIONS

- A. Manufacture and transportation only by company experienced in providing pre-cast products and services normally associated with pre-cast and pre-stressed concrete construction.
- B. Welders: certified in accordance with AWS D1.1 and AWS D1.4.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Handle pre-cast units in positions consistent with their shape and design. Lift and support only from support points indicated on Shop Drawings.
- B. Embedded Lifting or Handling Devices: Capable of supporting units in positions anticipated during manufacture, storage, transportation, and erection.
- C. Block and laterally brace units while stored at manufacturers. Provide lateral bracing that is sufficient to prevent bowing and warping that is clean, non-staining, and will not inhibit uniform curing of exposed surfaces.
- D. Provide edges of units with adequate protection to prevent staining, chipping, or spalling of concrete.
- E. Unless otherwise approved in writing, do not deliver units to job site until required for installation.

PART 2 PRODUCTS

2.01 CONCRETE

- A. Concrete for Above Ground Structures: Class 5000 minimum, in accordance with Section 03304, PORTLAND CEMENT CONCRETE, and ACI 318, unless a different strength of concrete is indicated.
- B. Concrete for Underground Structures: Class 4000 minimum, in accordance with Section 03304, PORTLAND CEMENT CONCRETE, and ASTM C478 or ASTM C858.

2.02 ACCESSORIES

- A. Connecting and Supporting Devices: Steel, in accordance with ASTM A36.
- B. Bolts, Nuts, and Washers: High-strength steel.
- C. Concrete Reinforcement: Grade 60 reinforcing for all pre-cast units unless approved in writing by Engineer.

2.03 FABRICATION

- A. Maintain plant records and quality control program during production of structural pre-cast concrete.
- B. Make records available to Engineer.
- C. Use molds which are rigid and constructed of material that will result in uniform finished products.
- D. Deposit and vibrate concrete to ensure proper consolidation, elimination of unintentional cold joints, and minimize entrapped air on surface.
- E. Fabricate required connecting devices, plates, angles, items fit to steel framing members, bolts, and accessories.
- F. Ensure reinforcing steel, anchors, inserts, plates, angles, and other cast-in items are sufficiently embedded, anchored, and properly located.
- G. Ensure finished surfaces of pre-cast structural units are uniform.
- H. Cure units under identical conditions to develop specified concrete quality, and minimize appearance blemishes such as non-uniformity, staining, or surface cracking.

2.04 DESIGN DEVIATIONS

- A. Deviation: Provide installation equivalent to basic intent without additional cost to Owner. Deviations from exact required cross-section will be permitted only with approval.
- B. Manufacturer's Proposed Design: Supported by complete design calculations and drawings. When requested, submit design calculations for review bearing seal and signature of Professional Engineer.

2.05 OPENINGS

- A. Provide required openings, 6 inches or larger. If approved, smaller sizes may be field constructed by coring or sawing.

2.06 FINISHES

- A. General: The required finish will be described in one of the following paragraphs. If no finish is indicated or selected by Engineer, the standard finish below shall be used.
- B. Standard Finish: Produced in forms such as plastic or metal lined that impart a smooth finish to the concrete. Small surface holes, normal form joint marks, minor chips and spalls are acceptable if approved. Major or unsightly imperfections, honeycomb, or structural defects are not acceptable.

- C. Commercial Finish: Produced in forms such as plywood or lumber that imparts texture to concrete. Remove fins and large projections and fill large holes. Faces: true and well-defined. Correct exposed ragged edges by rubbing or grinding.
- D. Architectural Grade A Finish: Produced in forms such as plastic or metal lined that impart smooth finish to concrete. Fill holes over 1/4 inch in diameter with sand-cement paste. Grind smooth form offsets to fins over 1/8 inch. Coat with neat cement paste using float. After paste coat has dried, rub with burlap to remove loose particles.
- E. Architectural Grade B Finish: Produced in forms such as plastic or metal lined that impart smooth finish to concrete. Fill holes over 1/4 inch in diameter with sand-cement paste. Grind smooth form offsets or fins over 1/8 inch.
- F. Special Finishes: Sandblasting, acid washing, retarders, or form liners as approved by Engineer. Special finishes require submittal of two 12- by 12-inch samples showing a representative color and texture to be used.
- G. Painted Finishes: Use only paint compatible form release agents on concrete that is to be painted.

2.07 REPAIR

- A. Repair of damaged units is acceptable if structural integrity or appearance is not impaired.

2.08 ALLOWABLE TOLERANCES

- A. Length: Plus or minus 3/4 inch, or plus or minus 1/8 inch per 10 feet of length, whichever is greater, or as indicated.
- B. End Squareness: 1/2 inch maximum.
- C. Blockouts: 1 inch of centerline location indicated.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Do not install pre-cast units until concrete has attained its design compressive strength.
- B. Install members plumb, level, and in alignment with PCI MNL-116 or PCI MNL-117 and indicated limits of erection tolerances.
- C. Clean weld marks or other marks, debris, or dirt from exposed surfaces of units.

3.02 PERFORMANCE REQUIREMENTS

- A. Conduct inspections, perform testing, and make repairs or replace unsatisfactory pre-cast units as required.
- B. Rejection: Units may be rejected for any one of the following:

1. Exceeding specified installation tolerances.
2. Damaged during construction operations.
3. Exposed-to-view surfaces that develop surface deficiencies.
4. Other defects as listed in PCI MNL-116 or PCI MNL-117.

PART 4 METHOD OF MEASUREMENT AND BASIS OF PAYMENT

4.01 METHOD OF MEASUREMENT

- A. Measurement of Precast Concrete Units shall be the number of each unit individually identified in the "Bid Schedule" complete in place and accepted.

4.02 BASIS OF PAYMENT

- A. Payment for Precast Concrete Units shall be based on the Contract Lump Sum Unit Price for each unit completed in place and accepted.
- B. Payment shall be considered as full compensation for furnishing all labor, materials, tools, equipment and other incidentals necessary to furnish, fabricate, transport and erect each completed Precast Concrete Unit.

END OF SECTION

SECTION 03600 — GROUT

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes pre-mixed non-metallic shrinkage resistant, pre-mixed water stop hydraulic cement, epoxy, and portland cement grouts.
 - 1. Grouting for leveling beds of structural steel plates.
 - 2. Sealing of joints and gaps between piping and structures.
 - 3. Sealing of joints between construction components.

1.02 REFERENCES

- A. ASTM C109: Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2 inch or 50 mm Cube Specimens)
- B. ASTM C144: Aggregate for Masonry Mortar
- C. ASTM C150: Portland Cement
- D. ASTM C157: Standard Test Method for Length Change of Hardened Hydraulic Cement Mortar and Concrete
- E. ASTM C190: Standard Test Method for Tensile Strength of Hydraulic Cement Mortars
- F. ASTM C207: Hydrated Lime for Masonry Purposes
- G. ASTM C472: Standard Methods for Physical Testing of Gypsum Plasters and Gypsum Concrete
- H. ASTM C595: Blended Hydraulic Cements
- I. ASTM C827: Standard Test Method for Early Volume Change of Cementitious Mixtures
- J. ASTM C881: Epoxy - Resin - Base Bonding Systems for Concrete
- K. ASTM D570: Standard Test Method for Water Absorption of Plastics
- L. ASTM D638: Standard Test Method for Tensile Properties of Plastics
- M. ASTM D695: Standard Test Method for Compressive Properties of Rigid Plastics
- N. CE-CRD-C-621: Corps of Engineers specification for grouts

1.03 SUBMITTALS

- A. Group mix components. Indicate proportions used, environmental conditions, and admixture limitations. Indicate material "Type", "Grade", and "Class" which suits project requirements.

- B. Manufacturer's data for latex bonding agent.

PART 2

PRODUCTS

2.01

MATERIALS - GENERAL

- A. Portland Cement: ASTM C150, natural color Type II (normal) or Type IIA (air entraining).
- B. Lime: ASTM C207, Type S, hydrated.
- C. Water: Clean, non-staining, and non-detrimental.
- D. Grout Aggregate: ASTM C144, standard masonry type.

2.02

PORTLAND CEMENT GROUT

- A. Proportions by volume shall be 1 part portland cement, and sand 2-1/2 to 3 times sum of volumes of cement and lime.
- B. Mix for 5 minutes maximum with sufficient water to form stiff plastic putty. Add water as required for workability.
- C. Compressive Strength: ASTM C 109, 2800 psi in 28 days.

2.03

GYPSUM PLASTER GROUT

- A. Pre-mixed, pre-packaged, wood fiber gypsum plaster with an ASTM C 472 minimum average dry compressive strength of 2000 psi in 28 days. Mix with water in accordance with manufacturer's instructions for intended use to form a stiff plastic mix required for workability.

2.04

NON-METALLIC, SHRINKAGE RESISTANT GROUT

- A. Pre-mixed, non-metallic, non-corrosive, non-staining product containing selected silica sands, portland cement, shrinkage compensating agents, plasticizing and water reducing agents, complying with CE-CRD-C-621.
- B. Compressive Strength: ASTM C109, 6500 to 9000 psi in 28 days.
- C. Non-shrink Percentage: ASTM C827 and ASTM C157, 0.5 percent.

2.05

EPOXY ADHESIVE GROUT

- A. Two component material suitable for use on dry or damp surfaces, 100 percent solids, high, moisture insensitive, complying with ASTM C881.
 - 1. Tensile Strength: ASTM D638, 5000 psi, minimum in 14 days.
 - 2. Tensile Elongation: ASTM D638, 2 percent minimum.
 - 3. Compressive Strength: ASTM D695, 6500 psi minimum in 24 hours and 70°F, 12,500 psi in 28 days and 70°F.

4. Water Absorption: ASTM D570, 1 percent maximum.
5. Bond Strength:
 - a. Direct Shear: 400 psi.
 - b. Direct Tension: 250 psi.
 - c. Beam Break: 800 psi.
6. Pot Life: 5 minutes maximum at 70°F.

2.06 BONDING GROUT

- A. Of approximately 1 part cement to 1 part fine sand passing a No. 30 sieve with approved latex bonding agent when allowed.

2.07 PNEUMATICALLY PLACED PLASTER ("GUNITE" OR "SHOTCRETE")

- A. Materials: Portland Cement, lime, water, and sand.
- B. Compressive Strength: ASTM C109, 2800 psi in 28 days.
- C. Proportioning: 1 part cement to not more than 5 parts sand.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Fill joints, voids, and pockets completely.
- B. Comply with manufacturer's instructions and UBC Chapter 47.
- C. Finish surfaces exposed to view smooth.
- D. Pneumatically Placed Plaster: Screened and reused rebound material in an amount not greater than 25 percent of the total sand in any batch.

PART 4 METHOD OF MEASUREMENT AND BASIS OF PAYMENT

4.01 METHOD OF MEASUREMENT

- A. Grouting for leveling for structural plates, sealing joints and gaps, filling voids and pockets and masonry cells shall not be measured for payment.
- B. Pneumatically placed plaster ("Guniting" or Shotcrete") will be measured by the actual areas in the plane of work.

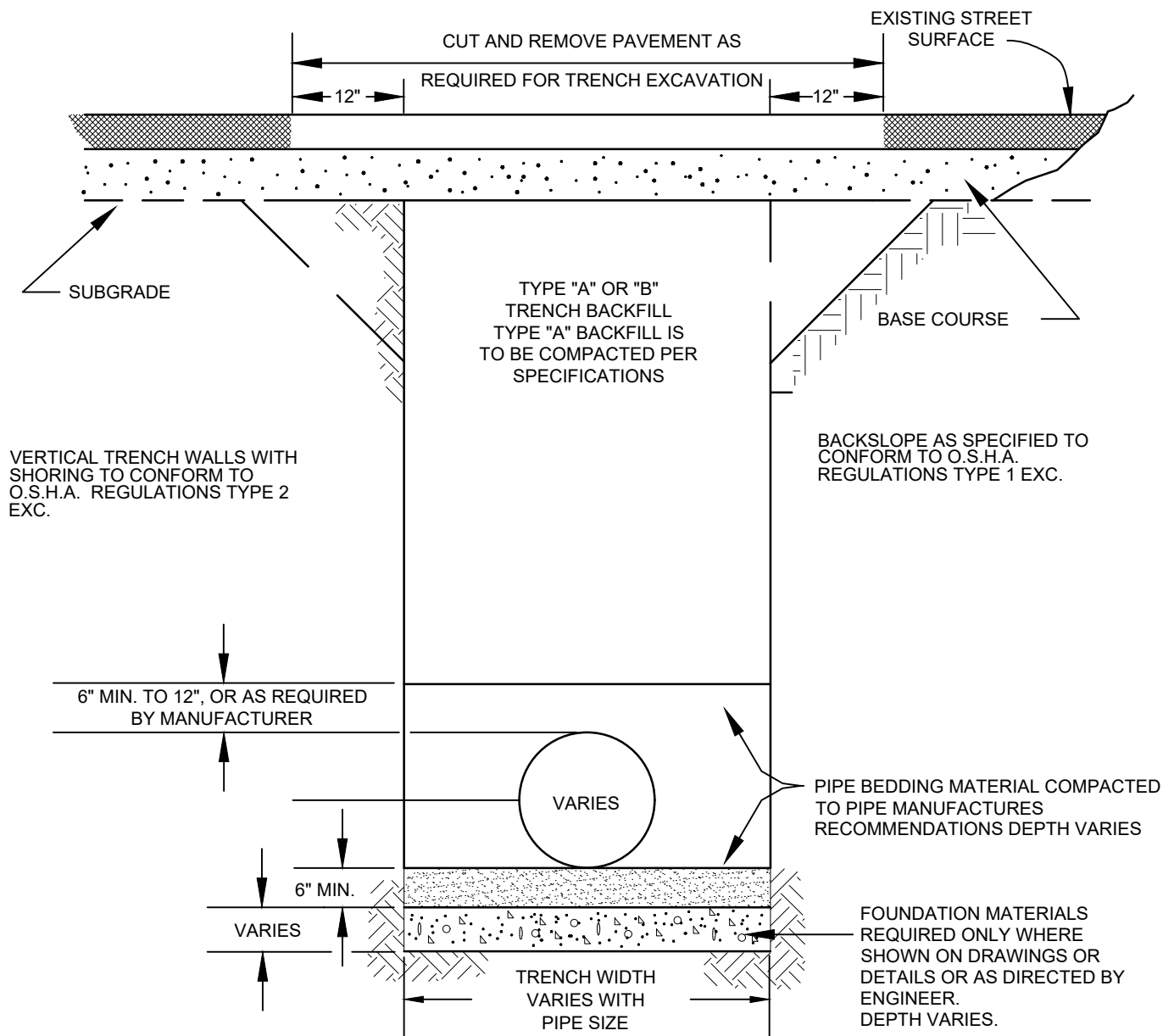
4.02 BASIS OF PAYMENT

- A. No separate payment will be made for items included in A. above. Full compensation shall be considered as included in the prices paid for the various contract items and no additional compensation will be allowed.

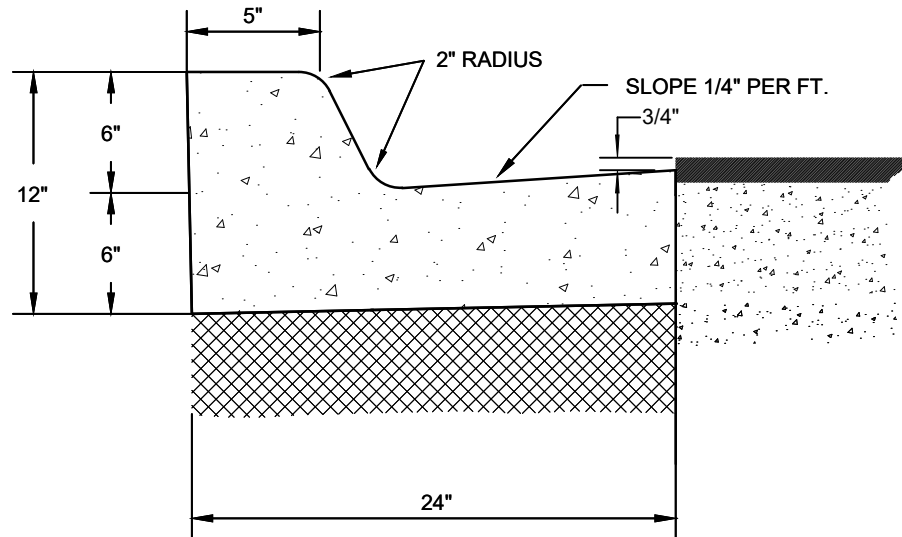
- B. Payment for Pneumatically placed plaster ("Guniting or Shotcrete") will be based on the Contract Unit Price Bid and shall include full compensation for preparing the foundation, setting all formwork, and grounds, furnishings and placing reinforcement, placing the concrete, finishing surfaces, curing and structural backfill as shown on the Plans. Full compensation shall be considered as included in the prices paid for the various contract items and no additional compensation will be allowed.

END OF SECTION

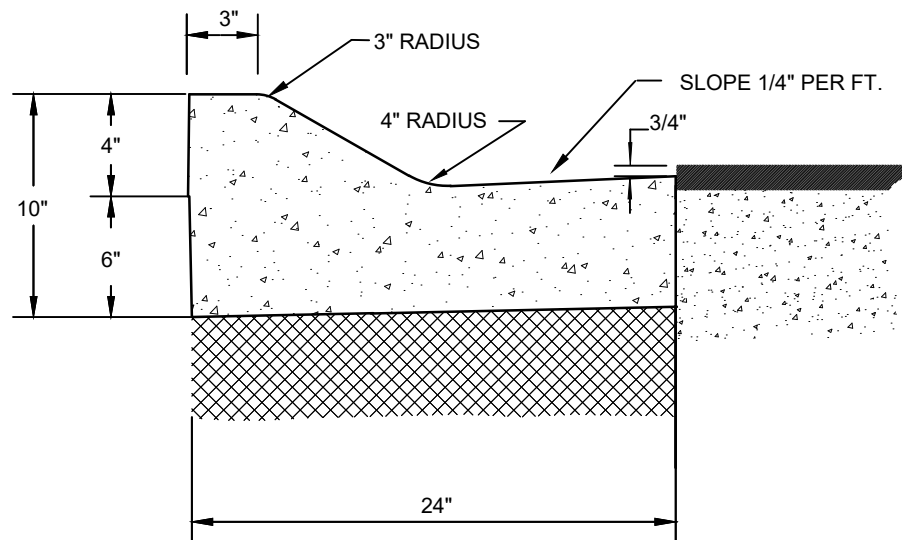
Standard Drawings



NOTE: WHERE TRENCH PASSES THROUGH EXISTING PAVEMENT THE PAVEMENT SHALL BE CUT IN ACCORDANCE WITH SECTION 02075-3.01 OF THE ATTACHED SPECIFICATIONS



TYPE "A"

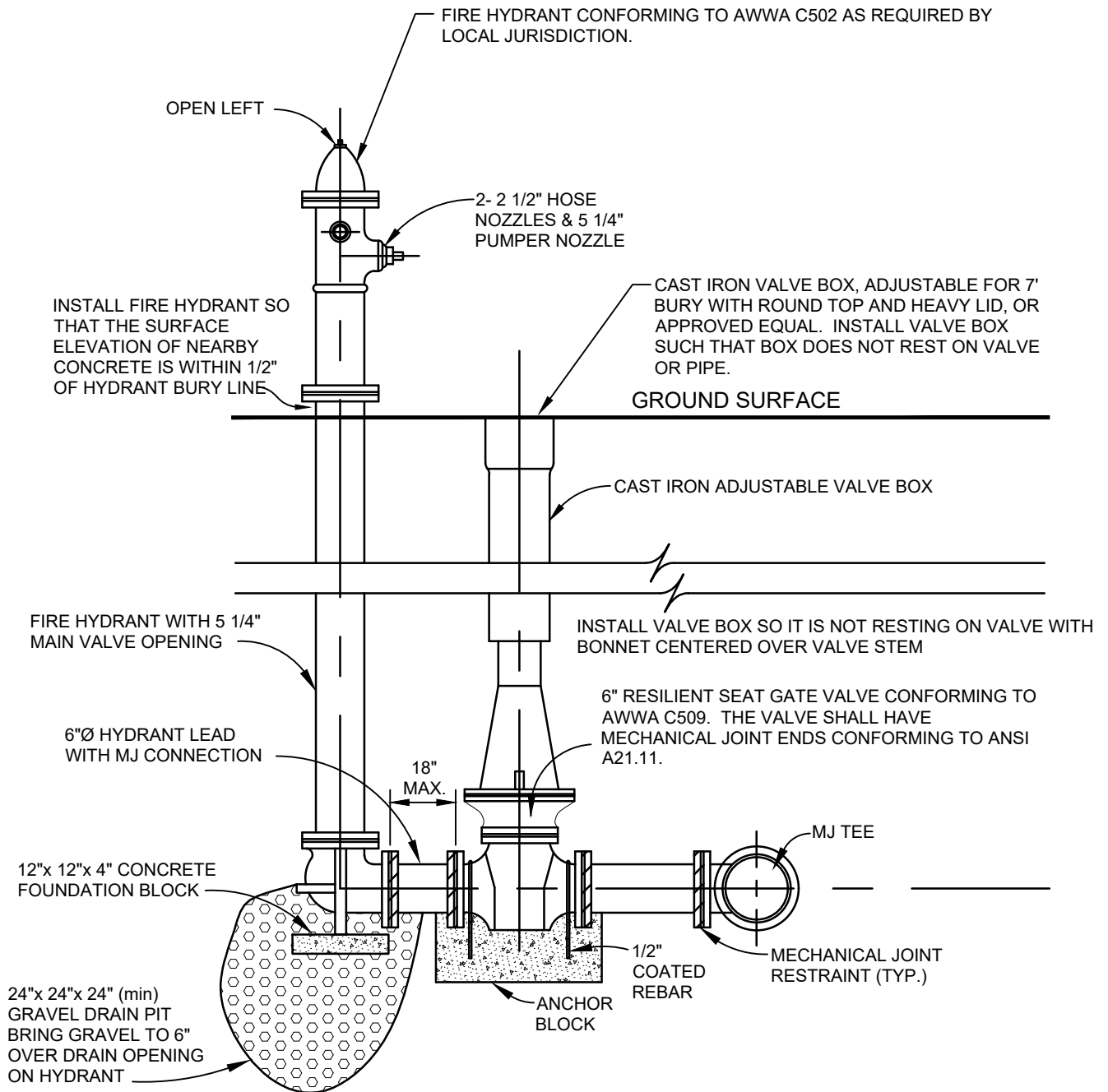


TYPE "B"

NOTES:

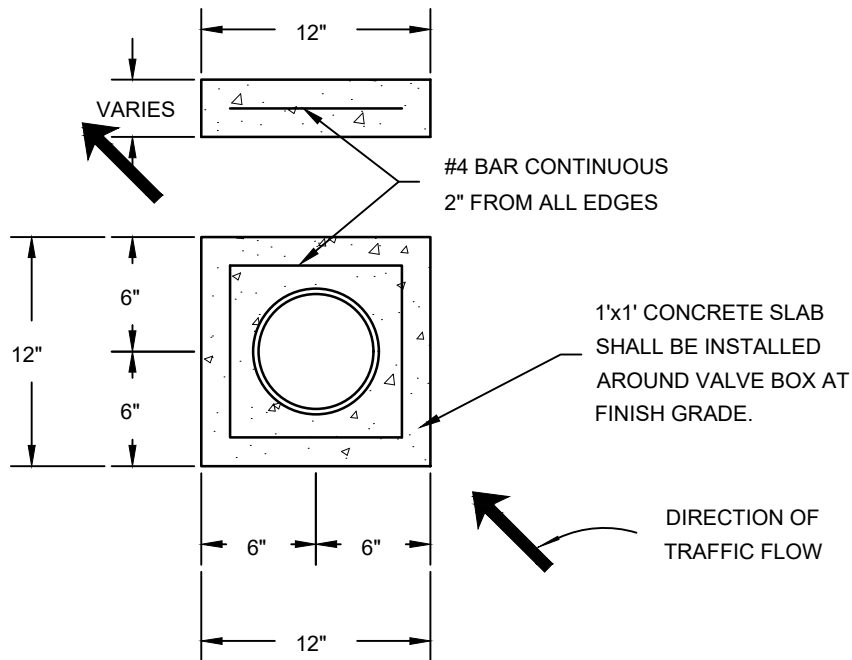
1. SUBGRADE COMPACTION SHALL CONFORM TO SECTION 02231
2. 1/2" EXPANSION JOINT MATERIAL SHALL BE PLACED AT P.C., P.T. AND CURB TURNS.
3. CONTRACTION JOINTS SHALL COMPLY WITH SECTION 02520.*
4. NO CURB AND GUTTER SHALL BE PLACED WITHOUT A FINAL FORM INSPECTION BY THE ENGINEER.
5. CLASS 4000 CONCRETE SHALL BE USED, SECTION 03304, PART 2.08.

* CONTRACTION JOINTS SHALL BE CONSTRUCTED BY SAWING OR SCORING. WHEN SCORING, A TOOL SHALL BE USED WHICH WILL LEAVE CORNERS ROUNDED AND DESTROY AGGREGATE INTERLOCK FOR SPECIFIED MINIMUM DEPTH.

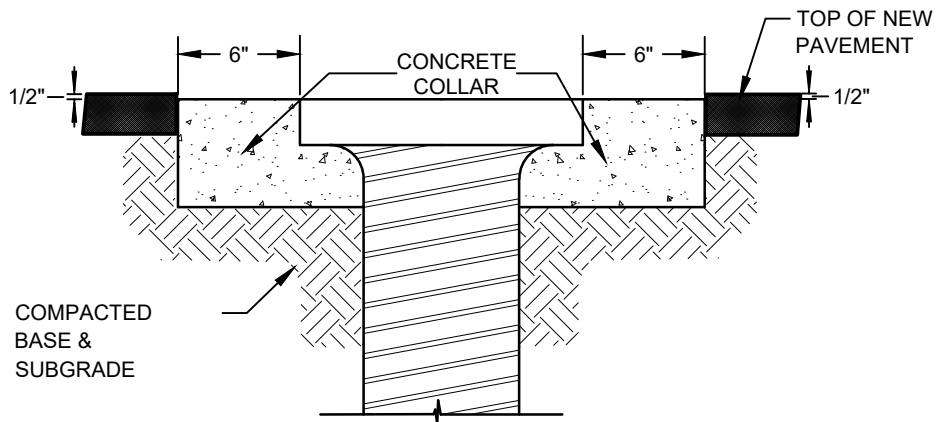


NOTES:

1. METAL TO BE WRAPPED WITH 8 mil POLYETHYLENE.
2. TRACER WIRE SHALL BE INSTALLED PER SPECIAL PROVISIONS.



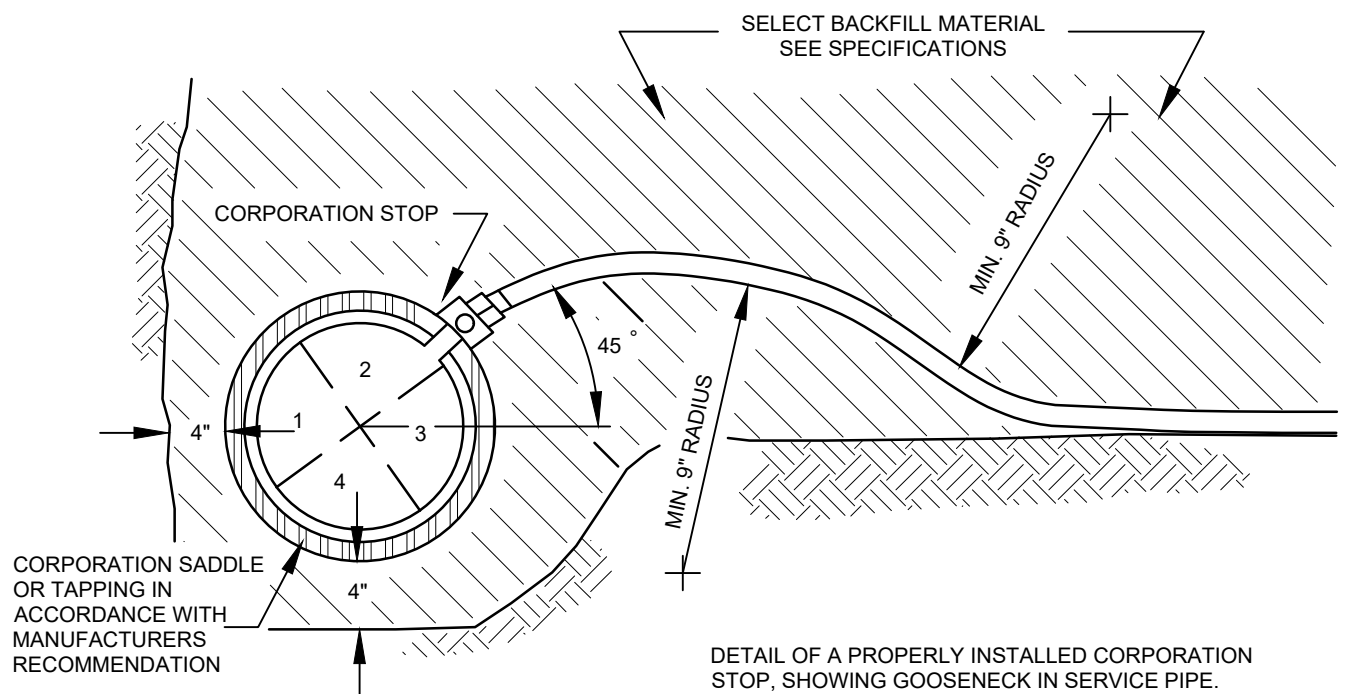
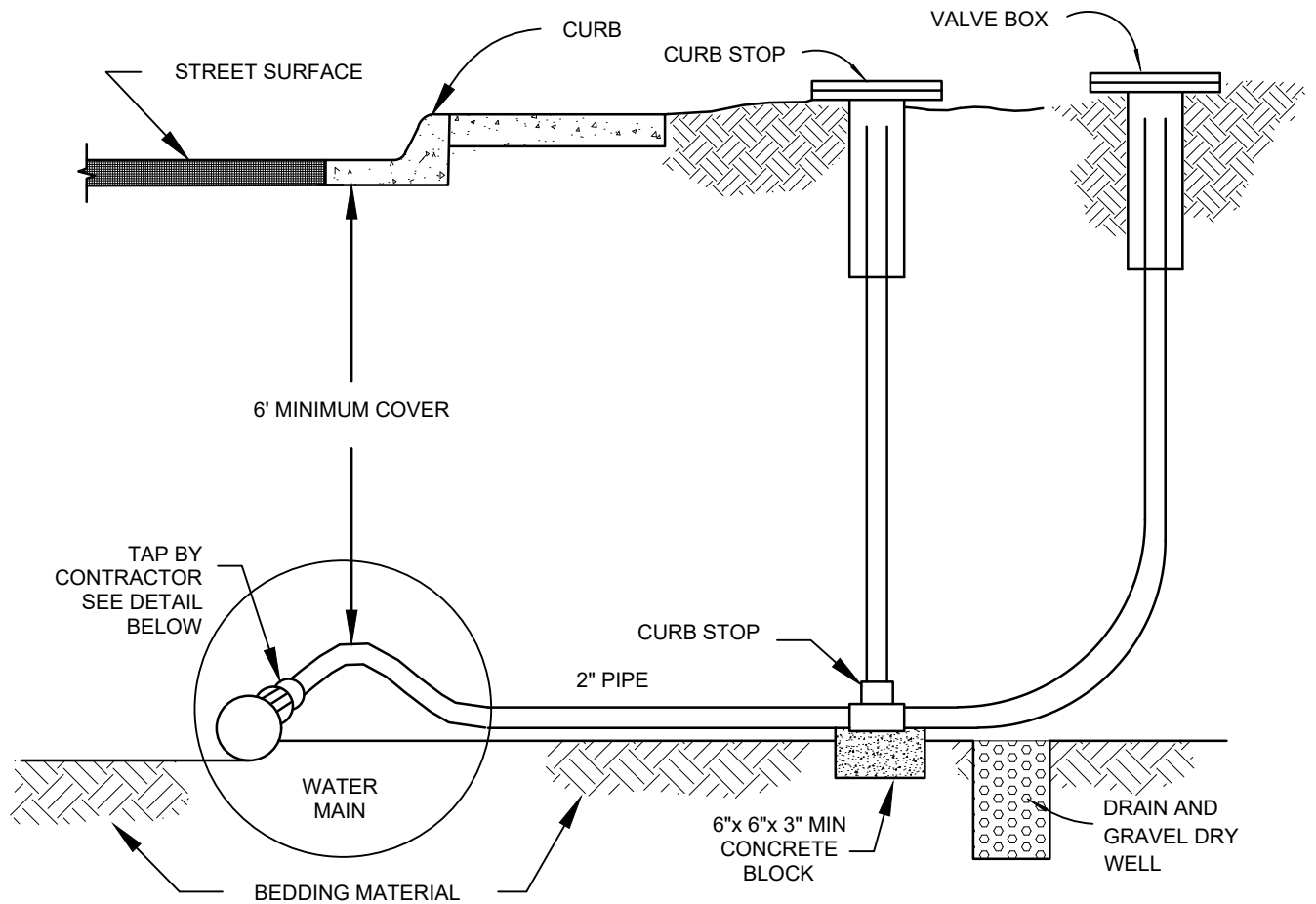
WATER VALVE COVER

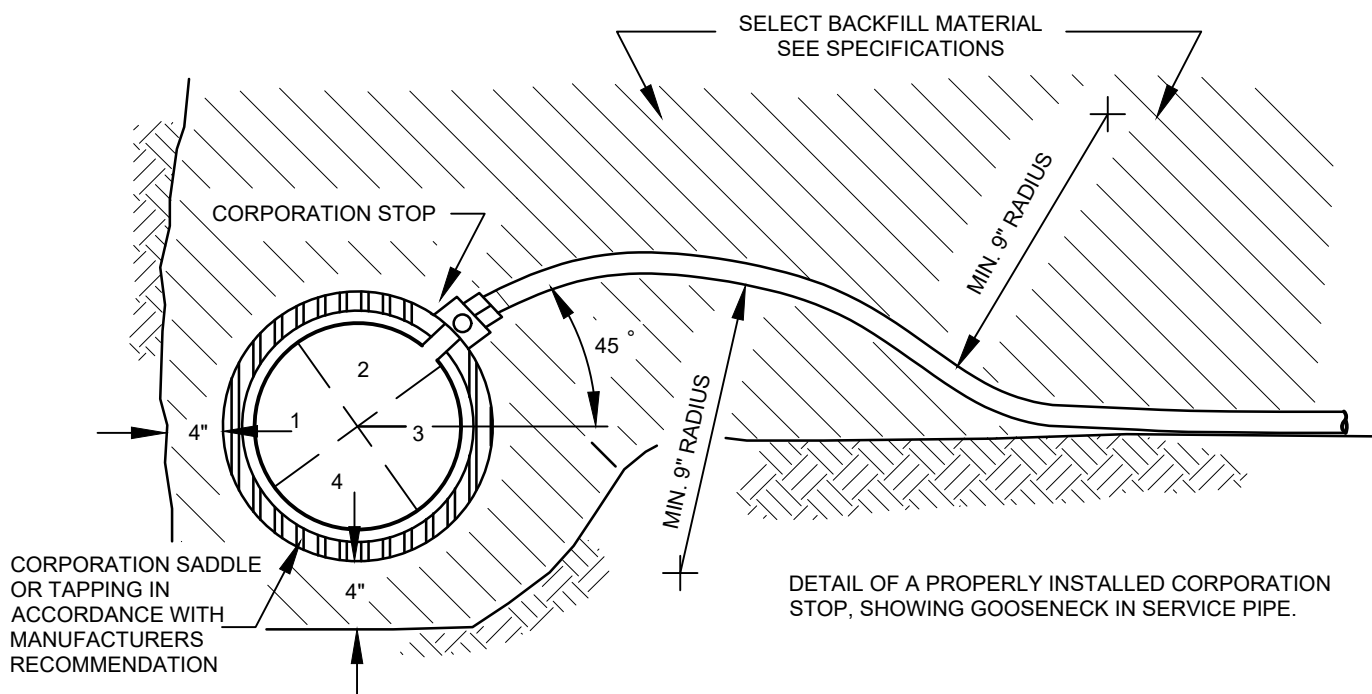
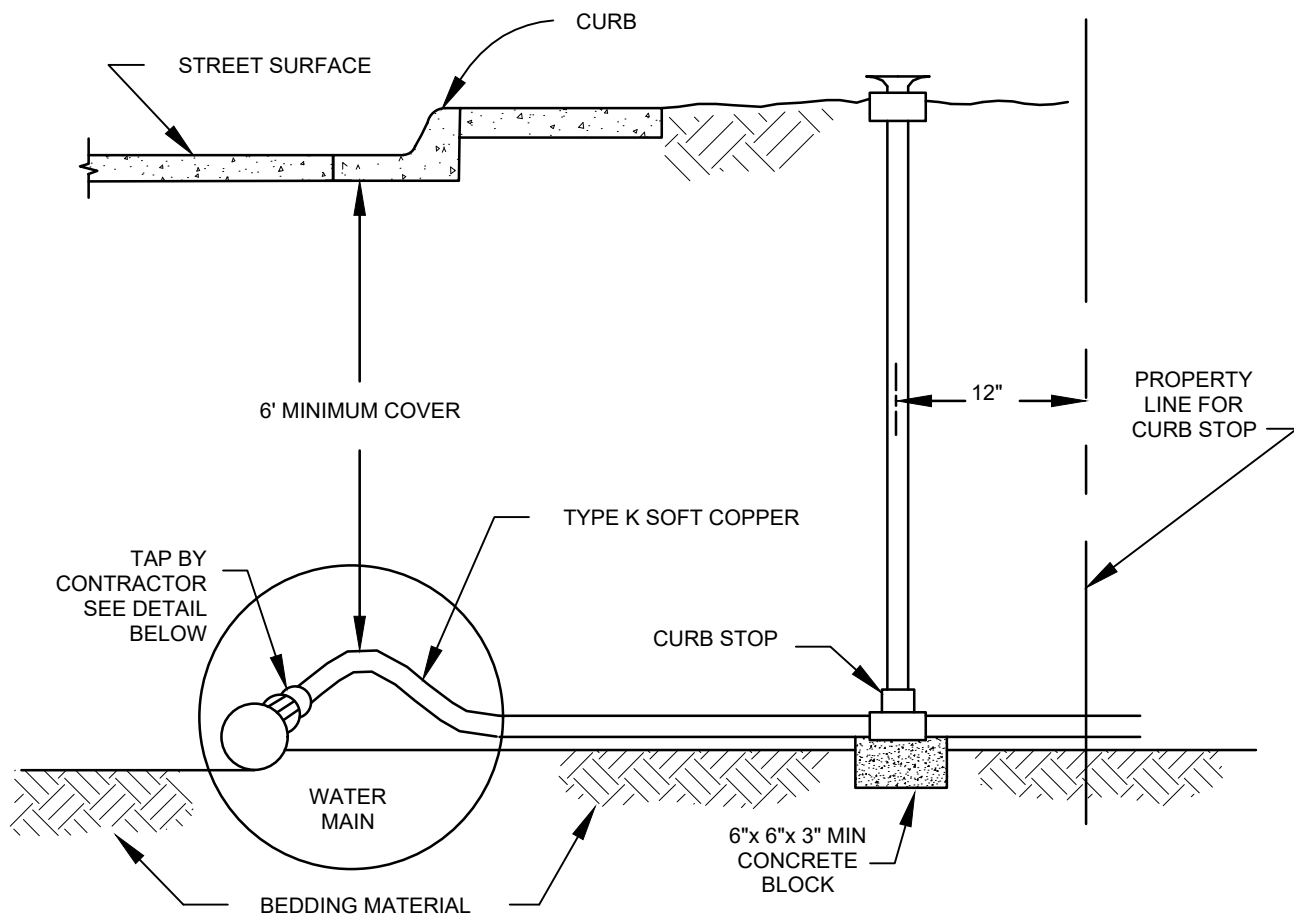


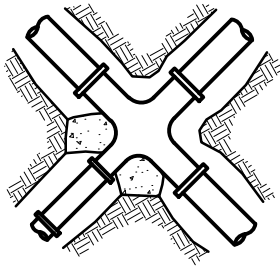
WATER VALVE ADJUSTMENT

NOTES:

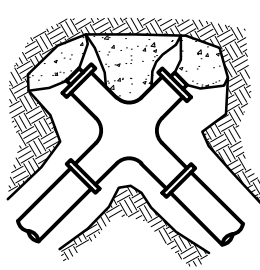
1. ADJUST WATER VALVES UPWARD OR DOWNWARD AS REQUIRED. FINAL ADJUSTMENT SHALL BE MADE AFTER PAVING AND BEFORE SEAL COATING. NO PAYMENT SHALL BE MADE FOR ADJUSTMENT OF NEW VALVES TO FINAL GRADE.
2. WHEN CONCRETE COLLAR IS POURED ABUTTING CONCRETE PAVEMENT, DEPTH SHOULD EQUAL THAT OF PAVEMENT SECTION.



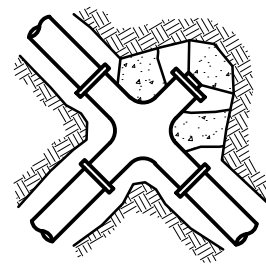




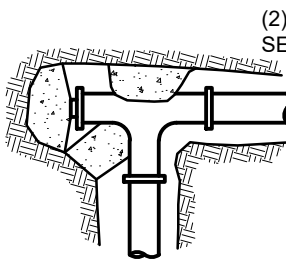
UNBALANCED CROSS



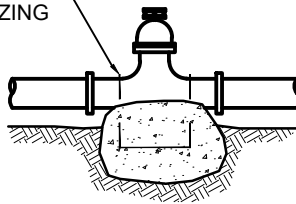
PLUGGED CROSS



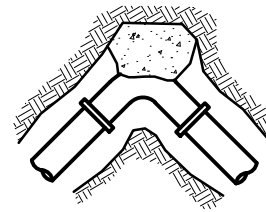
PLUGGED CROSS



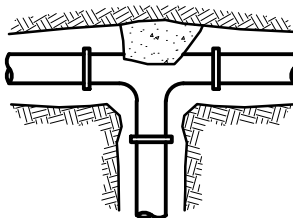
PLUGGED TEE



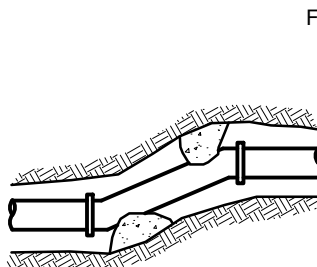
VALVE



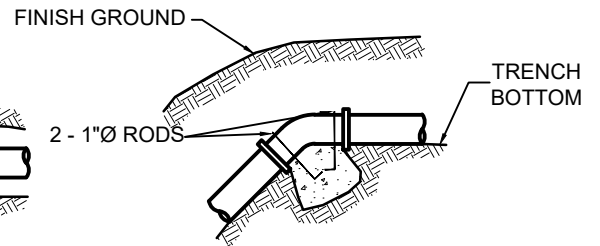
HORIZONTAL BEND



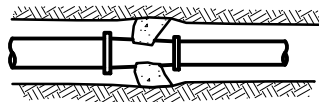
TEE



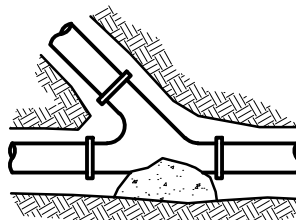
OFFSET



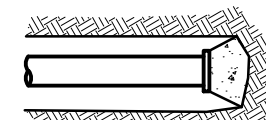
VERTICAL BEND
ENGINEER TO SPECIFY
CONSTRUCTION



REDUCER



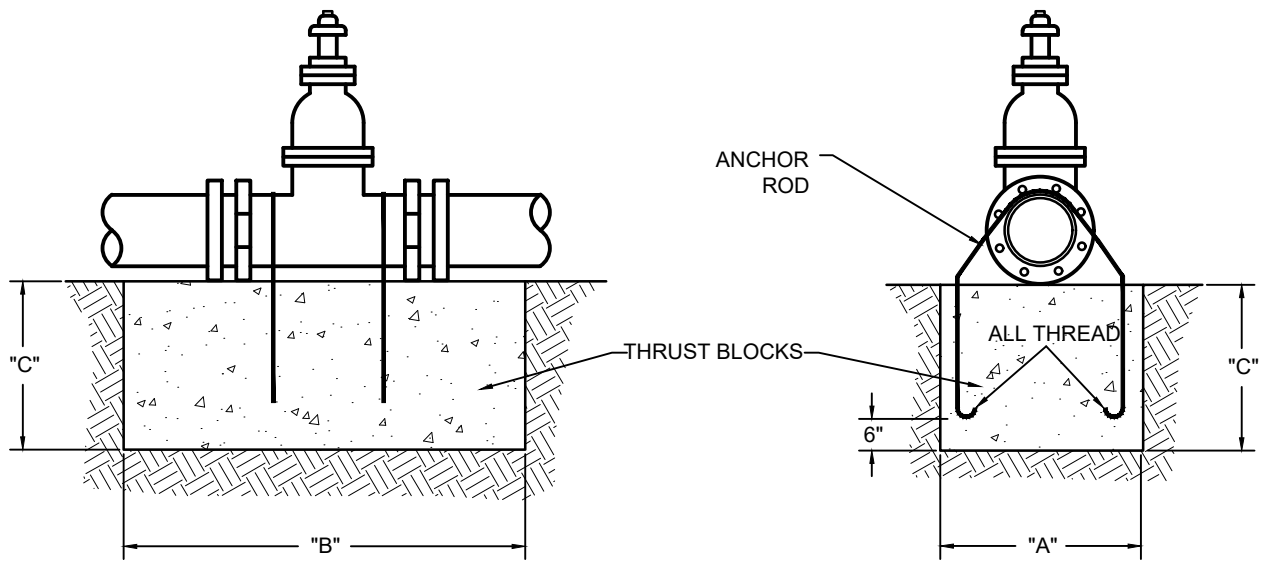
"Y" BRANCH



DEAD END

NOTES:

1. SIZE OF BLOCK SHALL BE A MINIMUM OF 6" THICK.
2. ALL BLOCKING SHALL BEAR AGAINST UNDISTURBED MATERIAL.
3. FITTINGS TO BE SEPARATED FROM THRUST BLOCK WITH AN APPROVED BOND BREAKER.



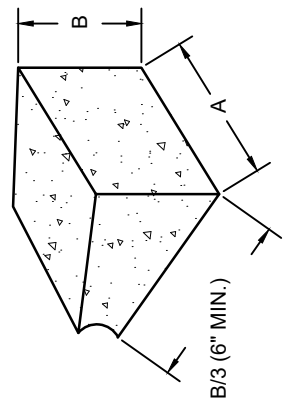
MINIMUM DIMENSIONS FOR THRUST BLOCKING								
ANCHOR ROD SIZE		3/4"	3/4"	3/4"	1"	1 1/8"	1 1/4"	1 3/8"
VALVE SIZE		6" & 8"	10"	12"	14"	16"	18"	24"
100 PSI	"A"	4'-4"	4'-4"	4'-4"	4'-4"	4'-4"	4'-4"	4'-4"
	"B"	4'-0"	4'-0"	4'-0"	4'-0"	4'-0"	4'-0"	4'-0"
	"C"	4'-0"	4'-0"	4'-0"	4'-0"	4'-0"	4'-0"	4'-0"
150 PSI	"A"	6'-5"	6'-5"	6'-5"	6'-5"	6'-5"	6'-5"	6'-5"
	"B"	4'-0"	4'-0"	4'-0"	4'-0"	4'-0"	4'-0"	4'-0"
	"C"	4'-0"	4'-0"	4'-0"	4'-0"	4'-0"	4'-0"	4'-0"
200 PSI	"A"	6'-6"	6'-6"	6'-6"	6'-6"	6'-6"	6'-6"	6'-6"
	"B"	5'-0"	5'-0"	5'-0"	5'-0"	5'-0"	5'-0"	5'-0"
	"C"	5'-0"	5'-0"	5'-0"	5'-0"	5'-0"	5'-0"	5'-0"
250 PSI	"A"	6'-5"	6'-5"	6'-5"	6'-5"	6'-5"	6'-5"	6'-5"
	"B"	6'-0"	6'-0"	6'-0"	6'-0"	6'-0"	6'-0"	6'-0"
	"C"	6'-0"	6'-0"	6'-0"	6'-0"	6'-0"	6'-0"	6'-0"
300 PSI	"A"	7'-8"	7'-8"	7'-8"	7'-8"	7'-8"	7'-8"	7'-8"
	"B"	6'-0"	6'-0"	6'-0"	6'-0"	6'-0"	6'-0"	6'-0"
	"C"	6'-0"	6'-0"	6'-0"	6'-0"	6'-0"	6'-0"	6'-0"

NOTES:

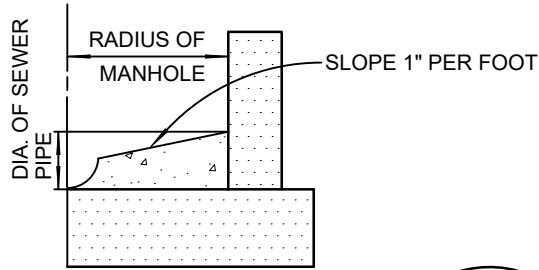
1. PRESSURES SHOWN ABOVE ARE MAXIMUM WORKING PRESSURE IN THE SYSTEM.
2. TO BE INSTALLED AS CALLED FOR AND AT THE LOCATIONS SHOWN ON THE PLANS.
3. COAT EXPOSED PORTIONS OF ANCHOR RODS WITH "KOPPERS" BITUMASTIC NO. 50 COATING OR APPROVED EQUAL.

MINIMUM DIMENSIONS FOR THRUST BLOCKING

FITTING SIZE	TEES & PLUGS		90° BENDS		45° BENDS & WYES		REDUCERS & 22 1/2° BENDS		11 1/4° BENDS	
	A	B	A	B	A	B	A	B	A	B
4"	1'-2"	1'-2"	1'-6"	1'-6"	0'-10"	0'-10"	0'-6"	0'-6"	0'-6"	0'-6"
6"	1'-11"	1'-11"	2'-2"	2'-2"	1'-7"	1'-7"	0'-10"	0'-10"	0'-6"	0'-6"
8"	2'-6"	2'-6"	3'-0"	3'-0"	2'-1"	2'-1"	1'-6"	1'-6"	1'-0"	1'-0"
10"	3'-3"	3'-3"	3'-10"	3'-10"	2'-9"	2'-9"	1'-11"	1'-11"	1'-0"	1'-0"
12"	3'-10"	3'-10"	4'-8"	4'-8"	3'-3"	3'-3"	2'-3"	2'-3"	1'-0"	1'-0"
14"	3'-10"	3'-10"	4'-11"	4'-11"	3'-5"	3'-5"	2'-5"	2'-5"	1'-6"	1'-6"
20"	5'-0"	5'-0"	6'-0"	6'-0"	4'-0"	4'-0"	3'-0"	3'-0"	2'-0"	2'-0"
24"	6'-0"	6'-0"	7'-0"	7'-0"	5'-0"	5'-0"	3'-0"	3'-0"	3'-0"	3'-0"
30"	7'-6"	7'-6"	8'-0"	8'-0"	6'-3"	6'-3"	4'-6"	4'-6"	3'-3"	3'-3"



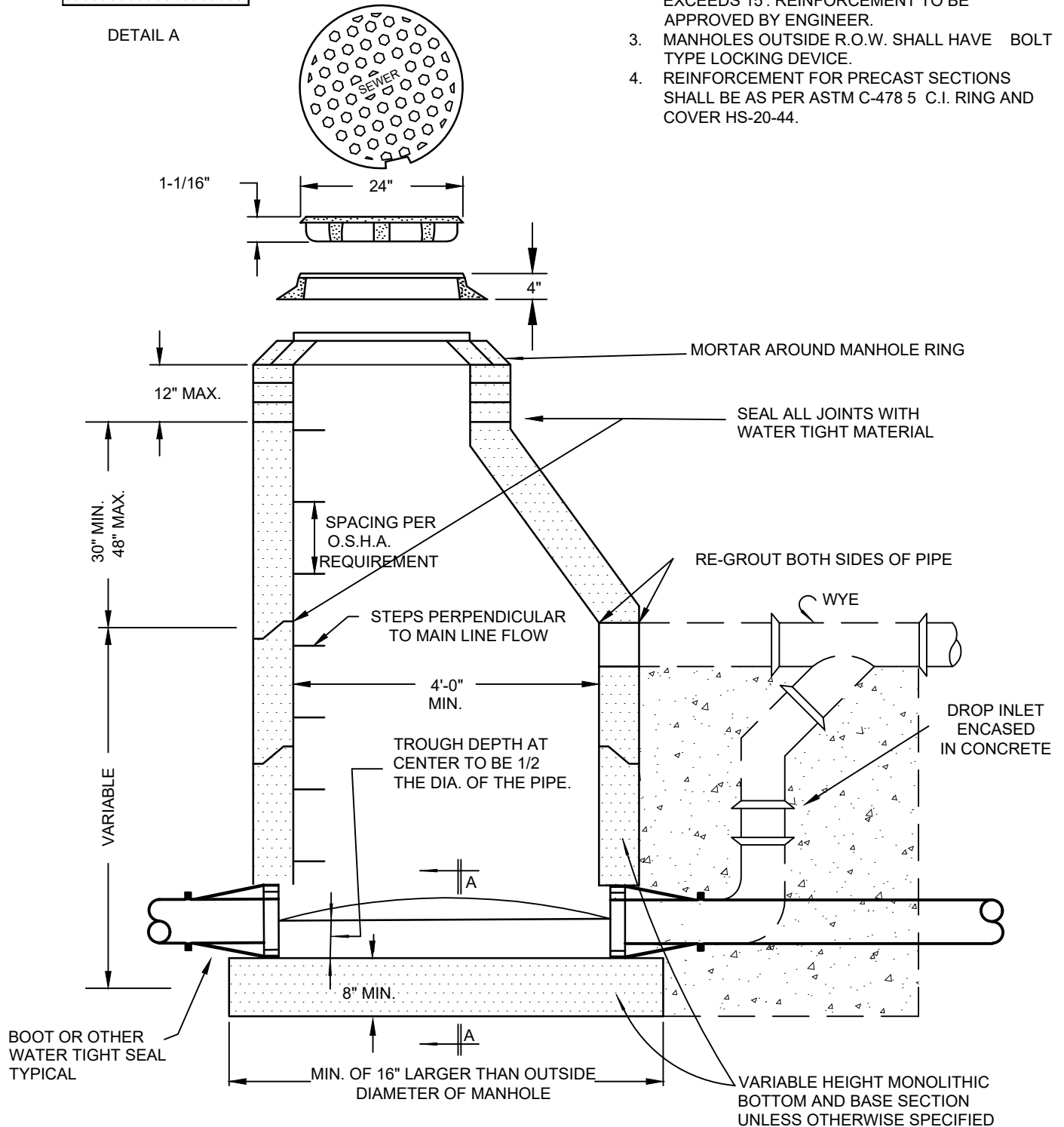
- NOTES:
- FITTINGS TO BE SEPARATED FROM BLOCKS WITH AN APPROVED BOND BREAKER, SUCH AS POLY WRAP.
 - ALL BLOCKS TO BEAR AGAINST UNDISTURBED MATERIAL.
 - DESIGN IS BASED ON 150 PSI MAIN PRESSURE AND 2000 PSF SOIL BEARING CAPACITY.

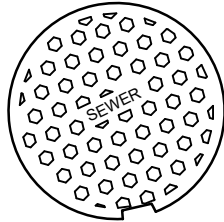
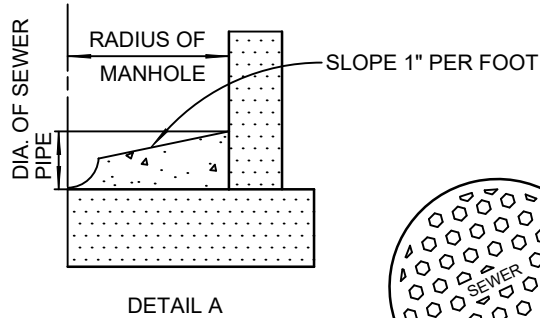


DETAIL A

NOTES:

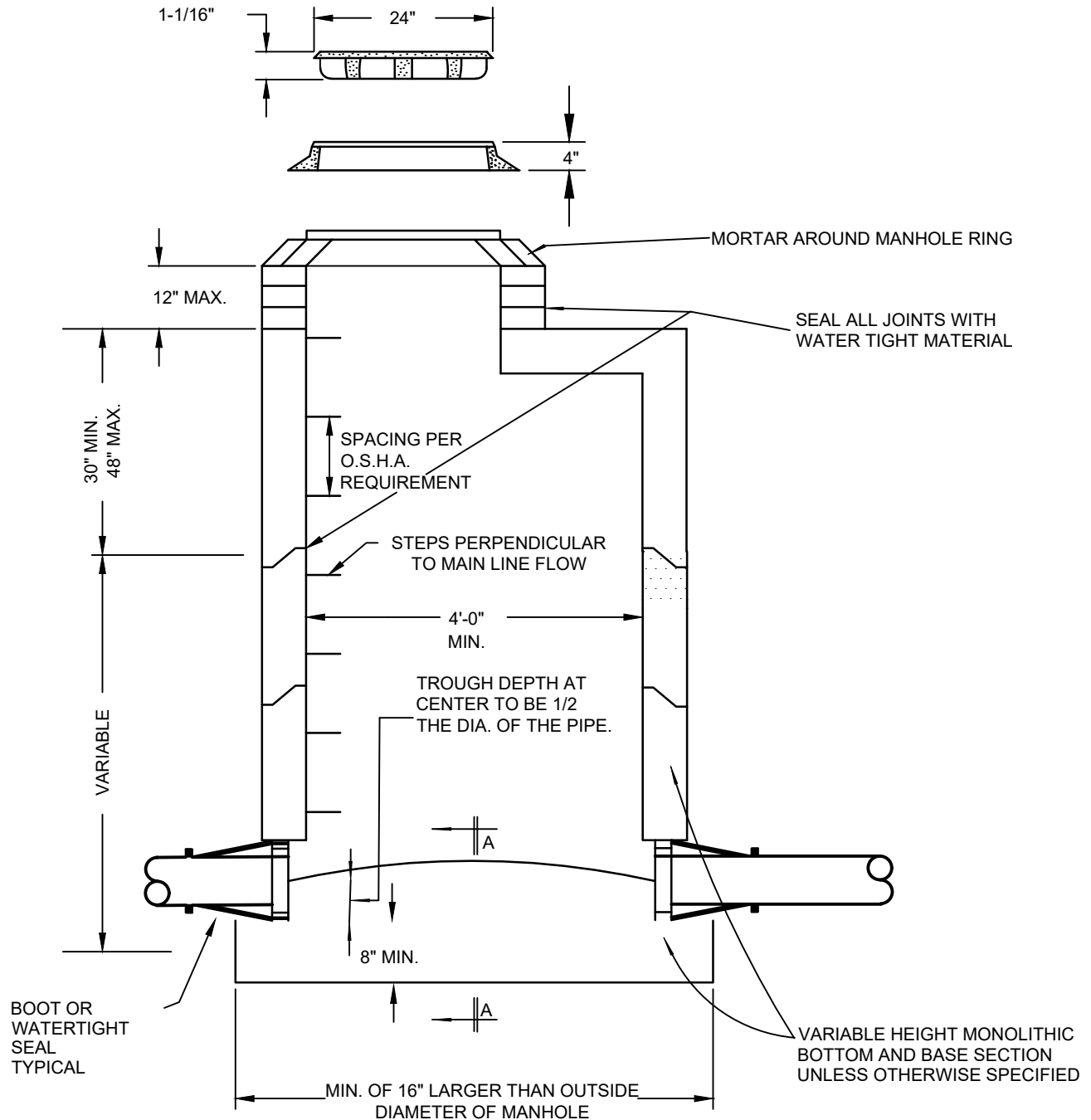
1. DROP ACROSS INVERT SHALL BE GREATER THAN OR EQUAL TO SLOPE OF ADJACENT SEWER.
2. BASES SHALL BE REINFORCED WHEN THE DISTANCE FROM INVERT TO TOP OF COVER EXCEEDS 15'. REINFORCEMENT TO BE APPROVED BY ENGINEER.
3. MANHOLES OUTSIDE R.O.W. SHALL HAVE BOLT TYPE LOCKING DEVICE.
4. REINFORCEMENT FOR PRECAST SECTIONS SHALL BE AS PER ASTM C-478 5 C.I. RING AND COVER HS-20-44.

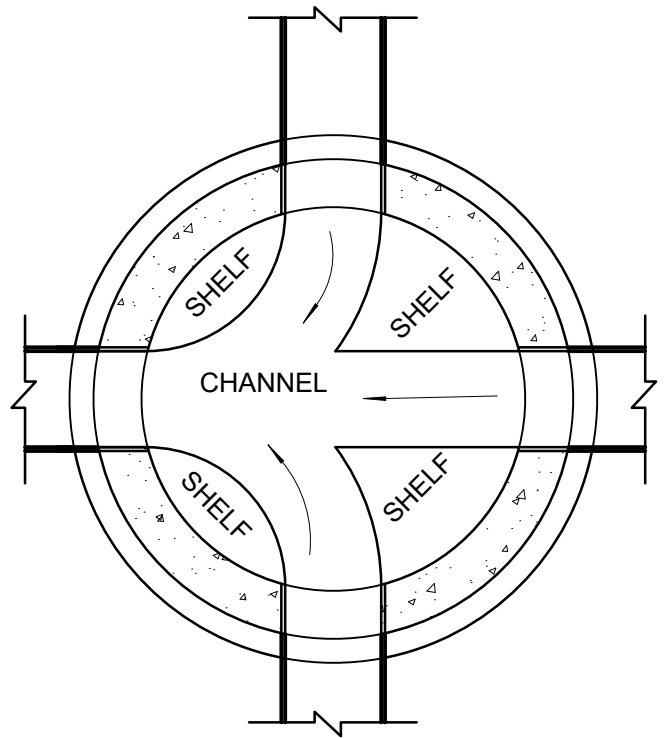
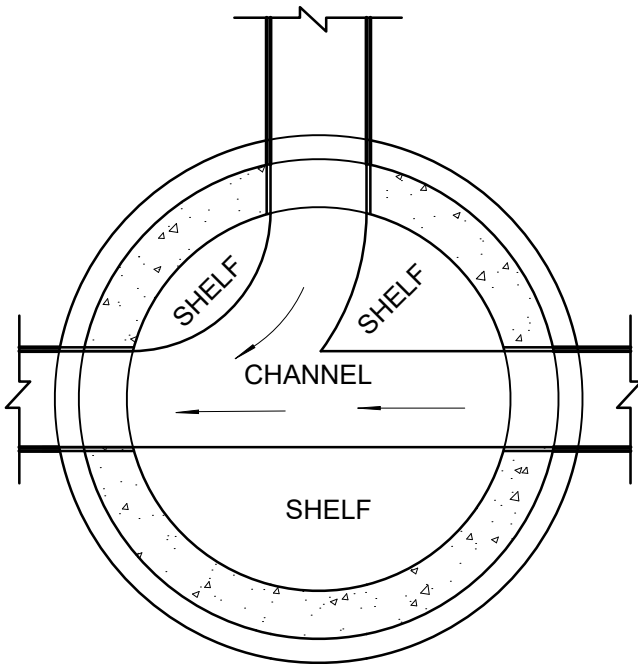
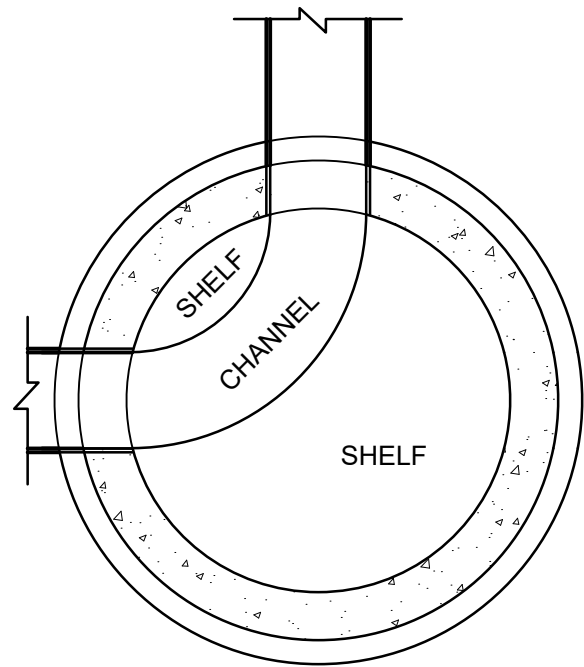
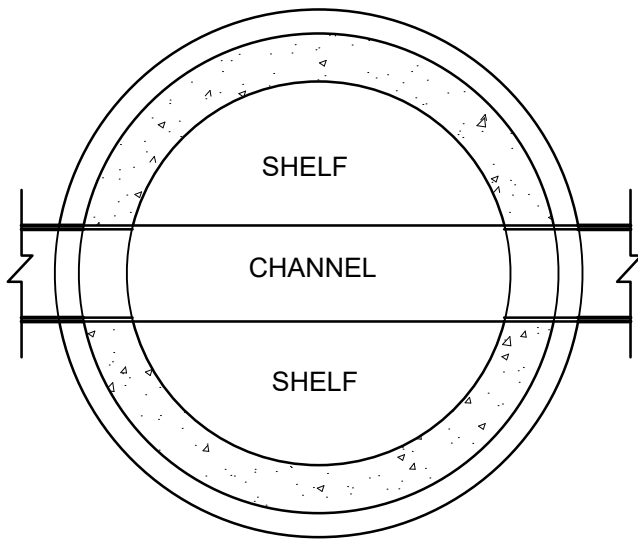




NOTES:

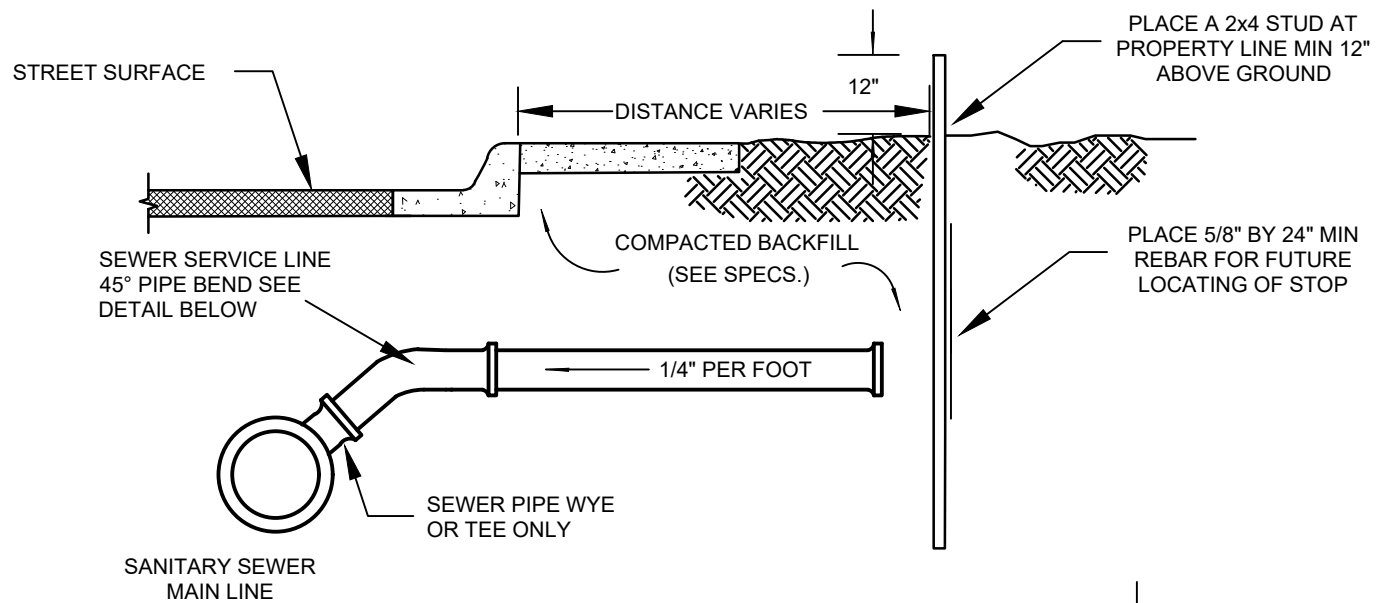
1. DROP ACROSS INVERT SHALL BE GREATER THAN OR EQUAL TO SLOPE OF ADJACENT SEWER.
2. BASES SHALL BE REINFORCED WHEN THE DISTANCE FROM INVERT TO TOP OF COVER EXCEEDS 15'. REINFORCEMENT TO BE APPROVED BY ENGINEER.
3. MANHOLES OUTSIDE R.O.W. SHALL HAVE BOLT TYPE LOCKING DEVICE.
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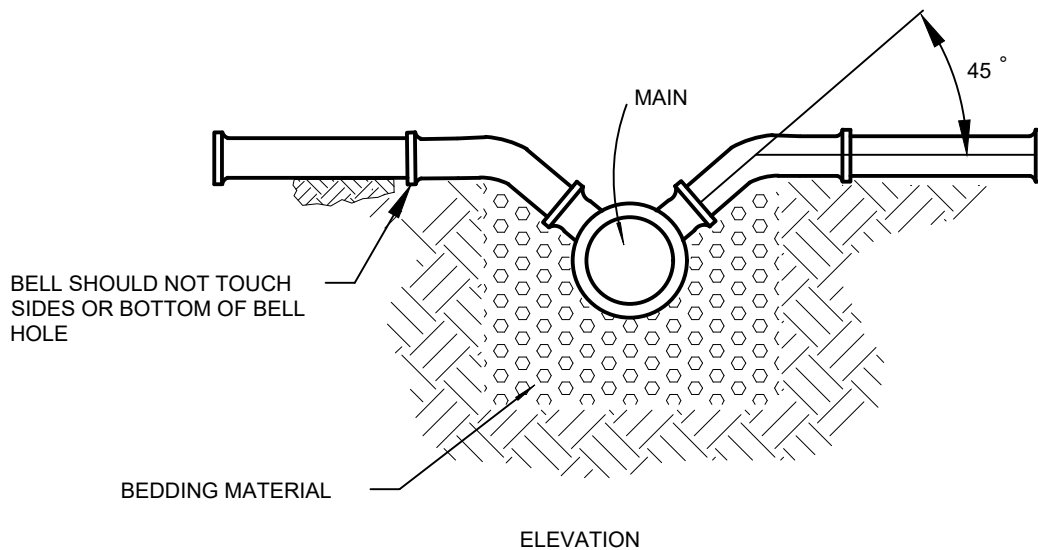
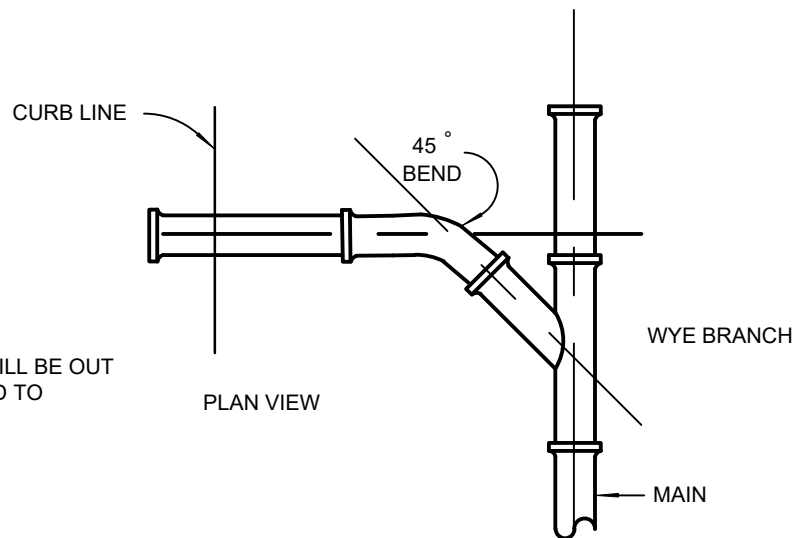


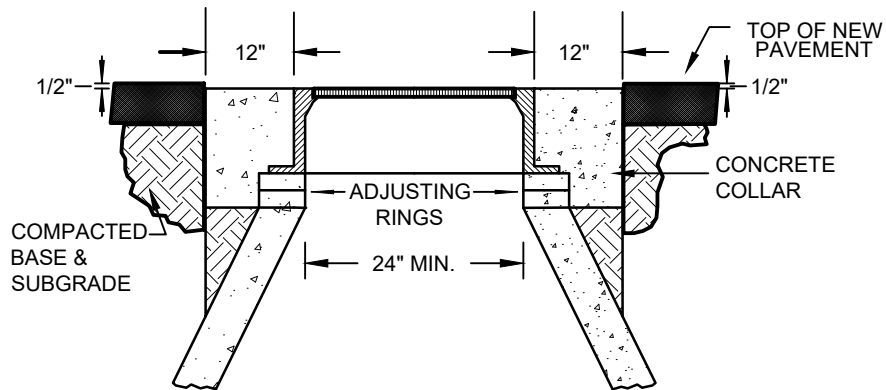
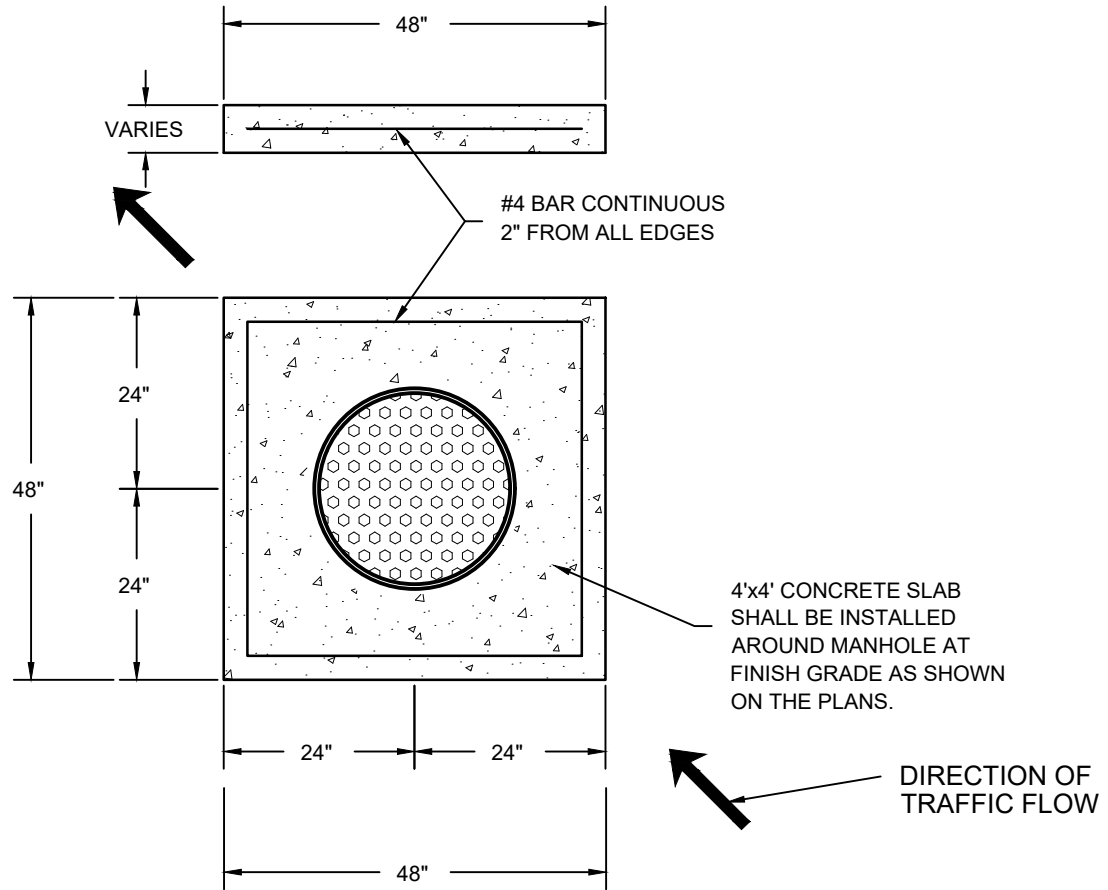
NOTES:

1. SLOPE ALL SHELVES TO CHANNEL AT 1" PER FOOT.
2. SEE PLAN-PROFILE SHEETS FOR SLOPE OF CHANNEL.



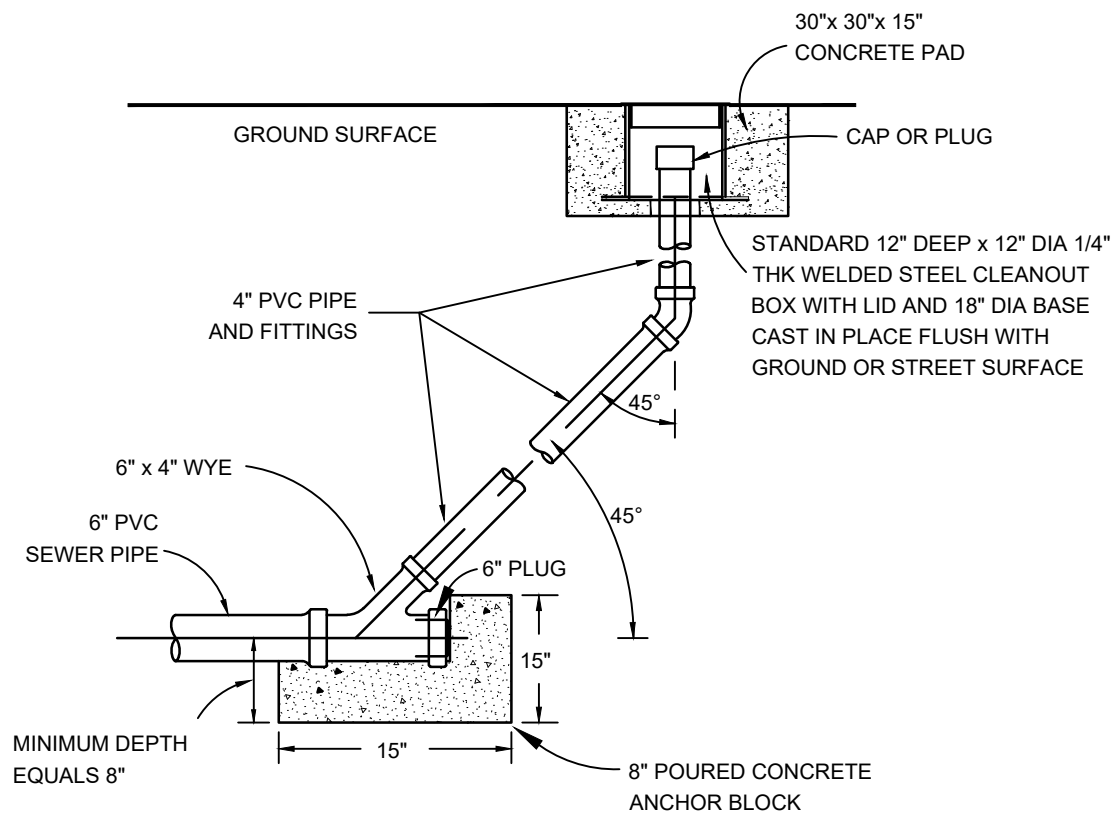
NOTE:
FOR PVC SERVICE STUB, BELL AT END OF STUB-IN WILL BE OUT
OF SQUARE. SOLVENT WELD CAP WILL BE INSTALLED TO
FACILITATE TESTING.

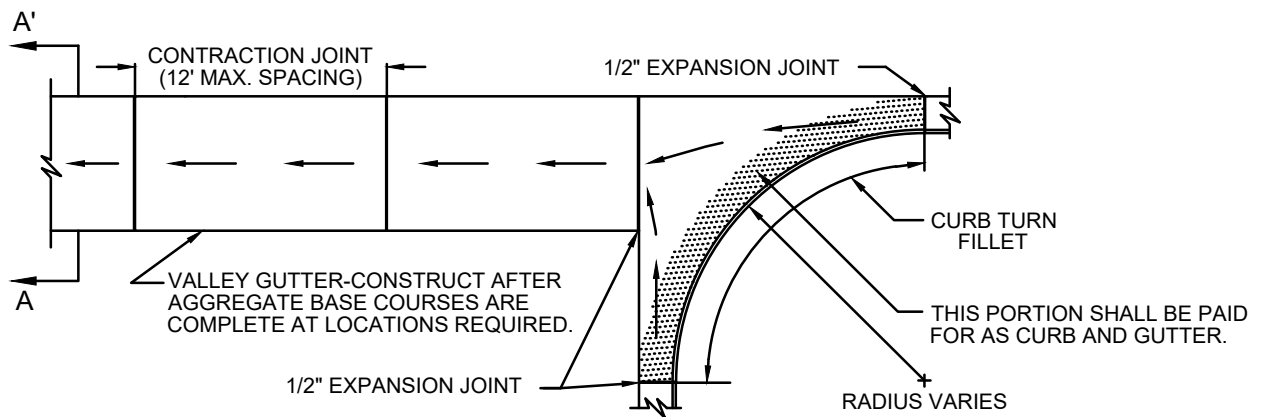




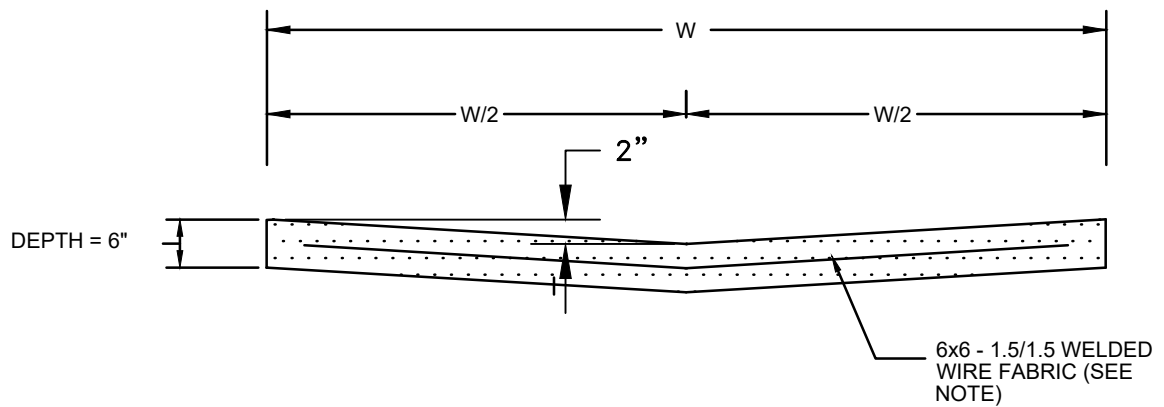
NOTES:

1. ADJUST MANHOLES UPWARD WITH BRICK & MORTAR OR ADJUSTING RINGS UNDER FRAME.
2. ADJUST MANHOLE DOWNWARD BY REMOVING A PORTION OF THE MANHOLE RISER AND REBUILDING TO PROPER DIAMETER.
3. SLOPE MANHOLE RING AS REQUIRED TO MATCH STREET GRADE AND CROSSLOPE.
4. FINAL MANHOLE ADJUSTMENT WILL BE MADE AFTER PAVING AND BEFORE SEAL COATING.





SECTION A-A'



NOTES:
FIBER REINFORCED CONCRETE OR #3 BARS @ 12" ON CENTER EACH WAY MAY BE
SUBSTITUTED FOR WELDED WIRE FABRIC UPON WRITTEN APPROVAL OF ENGINEER.

APPENDIX G

Northwestern Corporation
Authorization for Electric
Service

**NORTHWESTERN CORPORATION (NORTHWESTERN ENERGY)
AUTHORIZATION FOR ELECTRIC SERVICE, CHANGE IN ELECTRIC SERVICE OR DISCONNECTION OF
ELECTRIC SERVICE TO YELLOWSTONE NATIONAL PARK (YELL) UNDER
SERVICE AGREEMENT CONTRACT 140P2121A00005**

Pursuant to Contract No. 140P2121A00005 between the Contractor and the United States Government and subject to all provisions thereof, service to the United States Government under such contract shall be rendered or modified as hereinafter stated.

USE OF PREMISES TO BE SERVED: _____ (Residential, **Commercial**, etc)

SERVICE ADDRESS: _____

NATURE OF SERVICE: ☐ Connect ☐ Change ☐ Disconnect ☐ Continue Service
☐ Line Extension, Alteration, Relocation or Reinforcement ☐ Special Facilities

LOAD INFORMATION: ☐ Single Phase ☐ Three-Phase Voltage Required: _____

OTHER TERMS AND CONDITIONS: _____

CONNECTION: If "Connect" is selected above, the estimated connection charges shall be included in the executed Authorization.

Estimated Connection Charges: \$ _____

POINT OF DELIVERY: _____

TERM OF SERVICE (IF TEMPORARY): _____

ESTIMATED CONNECTION/SPECIAL FACILITIES CHARGE: \$ ^{NA} _____

ESTIMATED ANNUAL ENERGY USAGE: _____ KWH ESTIMATED DEMAND: _____ KW

ESTIMATED ANNUAL SERVICE COST: \$ _____

CLAUSES INCORPORATED BY REFERENCE (Check applicable clauses):

1.	☐	52.211-10	Commencement, Prosecution and Completion of Work (APR 1984)
2.	☐	52.236-5	Material and Workmanship (APR 1984)
3.	☐	52.241-12	Nonrefundable, Nonrecurring Service Charge (FEB 1995)
4.	☐	52.249-8	Default (Fixed-Price Supply and Service) (APR 1984)

BILLS WILL BE RENDERED FOR PAYMENT AT THE FOLLOWING ADDRESS:

11 E. Park St., Butte, MT 59701

The foregoing shall be effective upon the return of the fully executed original Authorization and an SF26 contract form by the utility to the ordering Agency.

ACCEPTED:

National Park Service, Yellowstone National Park

Northwestern Energy (Contractor)

By: _____
(Authorized Signature)

By: _____
(Authorized Signature)

Title: _____

Title: _____

Date: _____

Date: _____