Willow Creek Daylighting
Final - Early Feasibility Study
Edmonds, Washington

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GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

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1.0 INTRODUCTION

Willow Creek is a tributary to Edmonds Marsh, an estuarine tidal marsh located within the City of Edmonds (the City) (Figure 1). Willow Creek (393-acre basin) and Shellabarger Creek (378-acre basin) are the primary freshwater tributaries to Edmonds Marsh (SAIC, 2013). The current-day marsh flows along a 600-foot-long channelized ditch, "Willow Creek," then into a 1,600-foot long series of pipes, vault and tidegate system leading to the outfall point 200 feet offshore of the City of Edmonds Marina Beach Park, and discharging into the Puget Sound. The ditch, pipe, and tidegate system severely limit fish passage and tidal flow into Willow Creek and Edmonds Marsh. This early feasibility study evaluates the potential to restore tidal inflows and fish passage into Willow Creek and Edmonds Marsh. Several alternative alignments were evaluated, and a preferred alignment was selected for further evaluation of fish passage, marsh habitat improvements, and evaluation of potential floodplain effects. The feasibility study was performed for the City and EarthCorps (originally contracted with People for Puget Sound), and funded through a Salmon Recovery Funding Board Grant (Prism Project Number 11-1553N).

The marsh is currently bordered by State Route (SR) 104 to the east, Harbor Square to the north, the BNSF Railway Company (BNSF) railroad tracks to the west, and the Union Oil Company of California (Unocal) property (and Pine Street) to the south. Unocal is a wholly owned, indirect subsidiary of Chevron. The marsh is primarily owned by the City, with other bounding property owners including the Washington State Department of Transportation (WSDOT) (SR 104), the Unocal property to the south, BNSF property to the north and west, and Harbor Square property to the north. Edmonds Marsh receives freshwater flow from Willow Creek (to the south) and Shellabarger Creek (to the east).

The two relevant entities within the Chevron for the Edmonds Bulk Fuel Terminal site include 1) Union Oil Company of California (Unocal) and 2) Chevron Environmental Management Company (CEMC). Unocal owns the property and is the party responsible for complying with the agency directives regarding remediation. Unocal is also the party that WSDOT is purchasing the property from. CEMC is an affiliate of Unocal, and is performing the remediation on behalf of Unocal (Chevron, 2013a). For the purposes of this report, the property ownership and primary cleanup entity will be referred to as the "Unocal" property.

1.1 Study Purpose and Scope

The Willow Creek Daylight project is currently in the "early" feasibility stage of development. The purpose and scope of this phase of study is to explore the feasibility of providing (and maximizing) Chinook salmon access to rearing habitat, and evaluate the potential size and habitat types in Edmonds Marsh. The specific early feasibility study objectives include:

- Document the existing conditions, topography, and hydrology of the Edmonds Marsh complex.
- Screen and evaluate three daylight alternatives based on:
  - Fisheries functional and biological response,
  - Coastal hydrodynamics, and
  - Engineering, cost estimates, infrastructure, and property and political constraints.
- For the preferred alternative:
  - Develop a conceptual plan and cost estimate of the alternative,
  - Perform hydrodynamic modeling of the daylight alternative,
  - Quantify future juvenile Chinook rearing habitat areas,
  - Assess water depths and hydroperiods of potential rearing areas,
  - Evaluate impacts on flood water surface elevations, and
  - Provide information and recommendations for future phases of restoration design and permitting.

1.2 Ecosystem Restoration Context

Edmonds Marsh and Willow Creek have been impacted by historical rail development, industrial development and urbanization of City of Edmonds. Urbanization of the City's shoreline is similar to the documented urbanization effects throughout the Central Basin of the Puget Sound (Collins, Sheikh, 2005). Habitat losses of the Central Basin shoreline include hydrologic modification of streams and tidal systems, restricted fish passage and access, filling, and fragmentation and significant losses of pocket estuary marshes and lagoon complexes. The Central Basin Puget Sound shoreline is dominated by loss of freely available sediment sources, restricted fish access to small watersheds, and significant loss of historical backshore and pocket estuary, marsh, and lagoon complexes.

During the 20th Century establishment of the Great Northern Railway; industrialization of the waterfront by the logging, sawmill and shingle industries; development of the Port of Edmonds (the Port), and the urbanization of the City, all have contributed to significant habitat connectivity and habitat resource area losses. This reflects similar trends in anthropogenic modifications and losses that have contributed to an estimated 40 percent loss of pocket estuaries throughout the Puget Sound (PSNERP, 2011). The historical Edmonds Marsh has been estimated to have been more than 100 acres in size (Gersib 2008), extending from Point Edmonds north to Brackett's Landing, which today is the intersection of Main Street and SR 104. The current marsh area west of SR 104 is estimated at 27 acres, which is a loss of 73 acres and a corresponding 73 percent loss in historic marsh area.

Edmonds Marsh was historically a pocket estuary marsh formed by a sand-spit barrier that formed from coastal sediment shoaling patterns from south to north at Point Edmonds. The sand spit provided protection from coastal wave and wind forces to Edmonds Marsh. Pocket estuaries are partially enclosed bodies of marine water that are connected to a larger estuary at least part time, and are diluted by freshwater tributary runoff or groundwater sources (Pritchard, 1967). Pocket estuaries typically are formed as shoreline features including embayments, lagoons and ponds that develop behind coastal geologic and depositional features and include sand spits, barrier embayments and coastal inlets (Beamer, 2005).

These pocket estuary habitats provide juvenile Chinook (and other salmonids, prey and forage fish) with rearing, feeding, shelter and osmoregulation functions (Beamer and others, 2003). The Shared Strategy for Puget Sound Chinook Recovery (Redman and others, 2005) identifies barrier estuaries and features like it on the shoreline to be invaluable as resting, feeding, and physiological transition zones for the smallest life history types of migrating salmonids, including juvenile Chinook. Estuaries and marine nearshore habitats, particularly pocket estuaries and salt marshes, tend to be highly productive habitats with abundant prey resources. These prey resources are generally larger and more numerous than the fish encounter in freshwater rivers and streams; therefore, juvenile salmonids generally grow rapidly during this portion of their life history. The importance of growth by juvenile salmonids during their early marine life history is related to their overall survivability to return as adults. The early marine life stage is a crucial transition time for the fish, and fish attaining larger sizes during their first spring and summer tend to have a higher survival rate to returning as adults (hypothesized by Beamish and Mahnkens (2001), documented in hatchery fish by Duffy and Beauchamp (2011)).

Many juvenile Chinook salmon outmigrating from their natal rivers disperse to shallow shoreline habitats distributed throughout the Puget Sound region (Brennan et al. 2004; Beamer and Fresh

2012). Juvenile salmon in the nearshore of central Puget Sound are from streams in south, central, and north Puget Sound, as well as potentially the Fraser River and Hood Canal (Brennan et al. 2004).

Several researchers have documented the use of non-natal stream mouths by juvenile salmonids. A study in Hood Canal documented juvenile salmon use of non-natal tidal streams (Hirschi et al. 1999). Species observed included Chinook, coho, chum, and pink salmon. Twelve tidal streams were studied, none of which support Chinook salmon spawning, thus indicating that the juvenile Chinook captured had migrated into the tidal creek from the nearshore (non-natal). The authors hypothesized that despite the small size of the tidal streams and independent marsh habitats sampled, these non-natal estuarine habitats have a significant role in the juvenile salmon life history. In the Skagit River estuary and adjacent marine nearshore, Beamer et al. (2003) found that between February and May, more juvenile Chinook salmon used pocket estuaries than other nearshore areas. This research documents the preference of juvenile Chinook to utilize available pocket estuary habitats and their movements into these habitats from nearshore.

Todd Zackey of the Tulalip Tribes led an investigation of juvenile salmonid use of the lower reaches of small tributaries in Puget Sound's Whidbey basin. His study sites ranged from Mukilteo and South Whidbey Island to Skagit Bay and the Swinomish Channel. Salmon captured in the lower reaches of streams included Chinook, coho, chum, pink, steelhead (rainbow trout), and cutthroat trout. The study documented juvenile Chinook in 16 of 18 streams sampled (Zackey et al. 2011). Juvenile Chinook were captured each month between January and June in densities as high as 0.3 fish per square meter. Zackey et al. (2011) concluded that coastal streams are utilized by juvenile Chinook and merit additional consideration as important habitats for these fish.

Zackey (2013) also provided additional information to the Willow Creek study regarding juvenile salmon fish distributions in small streams according to stream gradient. Fry Chinook have been observed in low gradient areas at the mouths of small streams. In the case of Triangle Cove on Camano Island, juvenile Chinook use the brackish portions of the pocket estuary and lower reach of the stream. The preliminary results indicate that juvenile Chinook will utilize brackish marsh and brackish lower stream areas. Current studies by Zackey do not have an analogue with as long of reach of low gradient stream as the proposed Willow Creek daylight channel. Zackey is currently pursuing sampling efforts at sampling sites that may be more directly comparable to the Edmonds Marsh site.

Zackey (2013) also has been studying fish distributions in coastal streams along the eastern Central Puget Sound shoreline as far south as Picnic Point. He indicated that a key, limiting factor to juvenile Chinook use of coastal stream mouths is full blockage from the railroad culverts. Zackey is working with Adopt-A-Stream in collecting data of fish use downstream from the railroad culverts, and they have observed juvenile Chinook presence in these areas.

Zackey (2013) indicated recent presence studies found juvenile Chinook as far south as 22 miles and 26 miles south from the Snohomish River and Skagit River respectively. Edmonds is 16 to 18 miles from the Snohomish River and 32 miles from the Stillaguamish Rivers. It is very likely that juvenile Chinook migrate to Edmonds Marsh area. However, Beamer's work on pocket estuaries indicates that the migration populations are less dense the further away from the migration source river (Beamer, 2003). Even though the marsh is somewhat distant to large salmon bearing rivers, such as the Snohomish, Stillaguamish and Skagit Rivers, studies have documented migration to the City of Edmonds beach areas (Figure 2 - Adapted from King County 2004). Historical use by non-natal juvenile Chinook for juvenile rearing was highly likely in the Willow Creek/Edmonds Marsh system.

Between the Snohomish River and Edmonds, there are a number of small coastal stream deltas and shoreline drift zones that provide habitat for migrating juvenile fish. As was stated by Zackey, the coastal stream habitats are limited by the blockages created by the BNSF railway. Along this stretch of the Central Puget Sound nearshore area, there are limited estuarine marsh restoration opportunities and projects. A review of WRIA-8 Salmon Recovery Funding Board Grants, Puget Sound Nearshore – Estuary and Restoration Program, and the Puget Sound Nearshore Ecosystem Restoration Program indicate that the Edmonds Marsh, Willow Creek daylight project may be the largest tidal marsh estuary restoration project opportunity along this 20 mile section of the eastern, Central Puget Sound nearshore area and shoreline.

Willow Creek Daylight and the Edmonds Marsh estuary restoration represent a rare nearshore habitat resource, and prime restoration and habitat connectivity opportunity within the WRIA 8 nearshore area. The Willow Creek Daylight project is currently on the WRIA 8 three-year habitat work schedule (I.D. M233) and is listed as a Tier 1 project. Tier 1 designation indicates the highest quality remaining habitat, and the greatest Chinook use (WRIA-8, 2013).

2.0 HISTORICAL AND EXISTING SITE CONDITIONS

Historical conditions of the marsh have changed significantly since the marsh was originally mapped in 1870. Since that time the railroad, sawmill industry, forestry, farming and city urbanization have changed the landscape of the marsh. A brief historical change analysis is provided for reference purposes.

2.1 Historic Physical Conditions

Edmonds Marsh was historically a sand-spit, barrier (pocket) estuary marsh. The 1870s Government Land Office T-Sheet map shows the sand-spit barrier running north from Point Edmund, heading north towards Brackett's Landing, which is north of the current Washington State ferry terminal (Figure 3). The location and orientation of the spit were due to sediment shoaling, transport, and deposition in a northward direction from Point Edmund. The historical body of the sand spit was likely located near, what is today, the central area of the Port of Edmonds Marina. The historical tidal channel outlet of the channel was likely north of the N-dock, near the Port's administration office.

2.2 Anthropogenic Impacts to Edmonds Marsh

Edmonds township was settled in the 1870s after the discovery of the town site by George Brackett, who is considered by many the "founder of Edmonds" (History of Edmonds, 2012), and the namesake of the Edmonds Ferry "Bracketts Landing" location. European settlement, port development, rail construction, industrial sawmills, oil and gas production, and commercial and residential development essentially began in the 1870s.

In 1891, the Great Northern Railway reached the Edmonds shoreline and was established along the waterfront and western edge of the marsh on the historical barrier sand spit. The railway brought the opportunity for greater transportation and commerce to the region.

From the 1890s until 1951, the Edmonds waterfront was dominated by heavy industrial operations including sawmills and shingle mills. The last shingle mill was closed in 1951. The Unocal bulk fuel terminal facility was under construction as early as 1923 (Emcon, 1994). In the 1940s, the marsh area was farmed and used for cattle pasture (Figure 4). Of note, in 1944 the marsh had two large tidal channels with the main tidal channel outlet in what is now the Port of Edmonds Marina. Unocal leased the Harbor Square property in 1963 when filling of the marsh started (Emcon, 1994).

In 1923, the first automobile ferry was established between Edmonds and Kingston. Private ferry services were operated through 1950, when the ferry was taken over by the State of Washington Ferry System. The ferry dock is now located at what was historically the northwestern corner of the marsh. A recent study was performed by the Federal Highway Administration, the State of Washington, and the City to evaluate the feasibility and environmental impacts for possible relocation and construction of a multi-modal facility (and new Washington State ferry terminal) near the current Edmonds Marina Beach Park. This project is not currently moving forward.

In 1962, the Port of Edmonds completed construction of the Edmonds Marina. This included rerouting of the Willow Creek drainage south (to its current alignment) through a series of concrete pipes underneath the BNSF railway and Admiral Way, into a 48-inch corrugated metal pipe that flows south towards Edmonds Marina Beach Park. At the park, the creek flows into a storm vault which has a steel, top-hinge tidegate. Currently, this tidegate is allowed full operation (closing on incoming tides) from late October/early November through early March. In early March, the City staff hoists open the tidegate, which is held in that position until the next fall (October). This allows some (muted) tidal flows into the marsh. The configuration and operation of the pipe outfall system is described further in the existing conditions section of the report.

2.3 Union Oil Company of California (Unocal) Property

From 1923 to 1991, Unocal operated the Edmonds fuel station. Fuel would arrive by ship at the fuel dock that was located underneath the south parking lot at today's Edmonds Marina Beach Park (Figure 5). Fuel would be transferred via pipeline over the railroad tracks to processing facilities and storage tanks located on top of the bluff at Edmonds Point. Fuel was then distributed via fueling trucks to the greater Seattle region. The Unocal site was also used for asphalt production for more than 25 years. The Unocal site has residual contamination resulting from historic operations, and is being managed under an Agreed Order with the Washington State Department of Ecology. .

In 1993, Unocal entered into an "agreed order" with the Washington State Department of Ecology (Ecology) for remediation of the site (Chevron, 2013). In 2001, an interim cleanup plan was approved by Ecology and Unocal initiated cleanup work on the "Upper Yard," which was the processing and storage tank area on top of the bluff. One hundred and twenty-five thousand (125,000) tons of contaminated soils were removed from the yard. Ecology issued a letter confirming completion of the Upper Yard cleanup in 2003. Since that time, condominium units were developed on the Upper Yard, known as Point Edwards.

In the period of 2001 through 2003, several remediation actions were performed by Unocal on the 23 acre Lower Yard. In 2004, Unocal assessed the extent of contamination in the Lower Yard and verified that surface water and sediment in the Willow Creek Drainage ditch adjacent to the site were contaminated with polyaromatic hydrocarbons. The contamination was in part related to contaminants found in sediments located a historical stormwater outfall locations.

Chemical contamination from existing and historical industrial operations adjacent to the marsh is a concern for the study. The primary source of contaminant concern is the Unocal site are historical contamination including metals, polyaromatic hydrocarbons, total petroleum hydrocarbons, Light Non-aqueous Phase Liquids contaminants. The Unocal cleanup evaluated contamination of sediments along Willow Creek where contaminated sediments were found along Willow Creek and near site stormwater outfalls (Unocal, 2007).

In 2007 and 2008, Unocal conducted several remediation actions including excavation of more than 140,000 tons of contaminated soils and sediments exceeding Ecology standards, and removal of more than 9,000 gallons of petroleum product from the site, including cleanup of Willow Creek sediments. The project also included installation of a stormwater drainage system, regrading (fill), and planting native species on the site. Since 2008, Unocal installed 28 groundwater monitoring wells at the site. Data are being collected to determine if the remaining petroleum concentrations in the soil exceed the groundwater contamination standards. The monitoring efforts will be used to evaluate if additional cleanup actions are necessary at the site (Chevron, 2013). Monitoring is ongoing and communications with the Department of Ecology and the Unocal consultant indicate that a draft report is in development and will be available in December 2013.

Recent communications with CEMC and the Washington State Department of Ecology (Ecology) indicate that sediment sampling was conducted in Willow Creek from the tidal basin (straight/channelized section of the channel to the south and west of the storage ponds) upstream to where the Willow Creek enters Unocal property. Post remedial action sampling identified that a stretch of Willow Creek in an area northeast of the storage ponds required additional cleanup. This cleanup was completed as part of Interim Actions conducted in 2008 (South, 2013) and confirmed in sediment sampling performed in 2012.

Most contamination has been removed from the site, but some groundwater impacts remain. If Ecology believes additional sampling is needed to assess whether contaminant migration may have impacted sediments subsequent to the 2008 sediment cleanup, such sampling would be included in the Compliance Monitoring Plan for the site (South, 2013). Currently CEMC and ARCADIS are preparing a draft Feasibility Study. The draft is due to Ecology on December 27th, 2013. Ecology will be working with CEMC and ARCADIS in 2014 to finalize the Feasibility Study, select a cleanup action, and prepare a draft Cleanup Action Plan. The Cleanup Action Plan will not be finalized until after Ecology receives public comment (South, 2013).

In addition to the site remediation status, in 2005 Unocal entered into escrow for purchase and transfer of the entire lower yard property to WSDOT to be used for mitigation in the Edmonds Ferry, multimodal facility. Recent discussions between the City of Edmonds and WSDOT have indicated that the lower yard areas may no longer be required for mitigation and for the relocation of the ferry terminal access.

2.4 Existing Watershed Conditions

The Edmonds Marsh is located in an urban/suburban watershed. Two streams, Willow and Shellabarger Creeks, are the main stream inputs to the marsh. The City of Edmonds, Dayton Street/SR 104 study indicates that the contributing watershed basin to the Marsh is 833 acres (SAIC, 2013). Approximately 393 acres drain the Willow Creek basin and 378 acres drain the Shellabarger Creek basin, not including other smaller basins such as Harbor Square or Edmonds Point basins. The following section is a detailed description of the Willow Creek drainage system. Shellabarger Creek is treated as inflow to the Edmonds Marsh and Willow Creek system at the SR 104 culvert crossings. From this point downstream, this report describes the project as the Willow Creek/Edmonds Marsh system. Photographs that accompany the existing watershed descriptions are included in Appendix A.

2.4.1 Freshwater and Stormwater Inputs

The Willow Creek headwater area has two distinct sub-basins. The first sub-basin originates southeast of the marsh in a residential neighborhood within the City of Edmonds near 224th Street SW and 97th Avenue SW, near Westgate Elementary School. The second sub-basin originates south of the marsh in the town of Woodway near N. Deer Drive. Willow Creek flows as a stream channel with some stormwater pipes in the upper system. The creek enters Edmonds Marsh through a culvert at Pine Street, near the Trout Unlimited hatchery (Photograph 1). Historically, Willow Creek flowed along the southern margin of the marsh and along the Unocal stormwater detention pond and property (Figure 4). Over recent history, Willow Creek has filled with sediment and has a dispersed, unconfined flow pattern into the Edmonds Marsh freshwater emergent cattail vegetation. There has been some minor restoration and native revegetation activities along Willow Creek near the hatchery.

Shellabarger Creek is the next drainage system northeast of the Willow Creek, also originating near 224th Street SW and 95th Place W to the south and east, with Main Street the general boundary to the north. Shellabarger daylights near 4th Avenue S, flows in a confined channel between two apartment complexes, and discharges into a freshwater (stormwater) wetland east of SR 104. Shellabarger Creek flows beneath SR 104 in two 48- by 72-inch steel pipe arches just south of Harbor Square (and Dayton Street/SR 104 intersection) (Photograph 2). As Shellabarger Creek flows beneath SR 104, there is no distinct channel and the stream flows in an unconfined flow pattern into the Edmonds Marsh freshwater emergent cattail vegetation (Photograph 3). During large storm events, part of Shellabarger Creek flow travels north along the SR 104 east ditch towards the intersection with Dayton Street.

Hydrologic modeling data were made available for this study from the City's, Dayton Street and SR 104 stormwater study for Willow and Shellabarger Creeks (SAIC, 2013).

Harbor Square is a commercial area to the north of the marsh that discharges stormwater to the marsh through a series of pipes and bioswales.

These aforementioned stormwater inputs are at the upstream, northern end of the marsh and would be the primary (current) contributors of stormwater pollutants to the marsh. Several additional stormwater inputs flow into the marsh at the along the Willow Creek channelized section of stream (Photograph 4).

The Unocal property also discharges stormwater into the Willow Creek/ Edmonds Marsh system under the Unocal property industrial stormater discharge permit SO-002953C (Chevron, 2013a). There is a pump and pipe operation from the stormwater detention pond. Shannon & Wilson observed stormwater being pumped from the pond into Willow Creek on April 13, 2012 (Photograph 5).

WSDOT maintains a stormwater conveyance system that follows Edmonds Way/SR 104 south, and then east along the old Unoco Road. The southern extent of this basin has not been defined in the Dayton/SR 104 study. The basin may extend south a significant distance along 100th Avenue W. This pipe system crosses the Unocal property along Unoco Road and then

Willow Creek at the pipe outlet through the BNSF railway (see further description below). At this location, the WSDOT pipe manhole has been observed to overflow and dislodge the manhole cover and discharge to the Willow Creek system (Shuster, 2012) (Photograph 6). Hydrologic inflows from the WSDOT pipe system have not been estimated and are not known at this time. The WSDOT pipe system crosses the BNSF railway and Admiral Way and flows south, parallel to the Willow Creek 48-inch corrugated metal pipe, and then heads west through the Marina Beach Park, eventually discharging offshore from the park beach into the Puget Sound.

The Edmonds Point stormwater system outlets from the east into a 36-inch corrugated polyethylene pipe (CPEP). The outfall is located at the downstream (south) end of the channelized Willow Creek, near where the pipe crosses the BNSF railway and Admiral Way. Upstream from the Edmonds Point stormwater outfall, the system runs through a bioretention treament facility (Photograph 7).

There are likely other stormwater inflows from the BNSF railway and rail yard to the west of the channel.

Major inflows from Willow and Shellabarger Creeks were assessed in this study. Additional inflow information is recommended for the Edmonds Point, Unocal, and Harbor Square, and BNSF stormwater systems in future studies. It is recommended to also collect water quality data for each of the inflow and stormwater tributaries for future studies.

2.4.2 Marsh Vegetation and Stream Flow Hydraulics

Edmonds Marsh supports freshwater and salt-tolerant plant species, with a fairly distinct transition in vegetation type occurring midway along the marsh as observed running from the Harbor Square tennis courts to the eastern edge of the Unocal stormwater detention pond. Earlier studies have reported that the emergent salt marsh plants are restricted to lower elevations compared to other salt marshes in Puget Sound and attributed this to the constriction of tidal flow through the pipe and culvert system (Pentec, 1998). This is likely an effect of tidal muting, whereby significant conveyance losses occur in the stormwater pipes, vaults, and confined ditch and allow only a portion of saltwater tidal flow into the marsh. Also, the operation of the tidegate in winter months limits inflow and tidal exchanges that affect marsh vegetation and habitats. The existing marsh vegetation and habitat estimates include 3.2 acres of mudflats, 5.9 acres of low salt marsh vegetation, 11.4 acres of freshwater marsh, and 6.1 acres of forested wetland.

The downstream (western) portion of the marsh shows evidence of saltwater vegetation, tidal channels, and mudflats (Photograph 8). Distinctive tidal channels are observed running adjacent to the Unocal stormwater detention pond on the south side of the marsh, and a larger tidal channel originating at the northern edge of the marsh near the Harbor Square tennis courts.

Historically, Willow Creek flowed in a ditch along the western side of the marsh near the Unocal stormwater detention pond. During recent stream reconnaissance, it was observed that Willow Creek has filled with sediment and there is no direct connection to this relict ditch. Instead, Willow and Shellabarger Creek both disperse flow in thick and dense cattails when the streams enter the marsh. There were no distinct stream channels observed in the marsh.

At the westernmost location of the marsh and northwestern corner of the Unocal stormwater detention pond, Willow Creek flows into a 700-foot-long, confined, channelized ditch along the BNSF embankment (Photograph 4). The Unocal website indicates that that a 420 foot long area has been planted with native vegetation, likely along the downstream portions of the existing channel. Shannon & Wilson observed little native vegetation with stands of invasive scotch-broom along the upstream (north) sections of the existing channel.

The channel has little to no overhanging vegetation, cover, or instream habitat (such as large woody debris). The channel appears to be wholly located within the Unocal property, based on geographic information system information provided by the City (City of Edmonds, 2012). Recent communications with the City indicate that this section of the Unocal property remains in escrow with WSDOT, who had originally planned to use the property for stream mitigation for the Edmonds Crossing project. We recommend the Unocal property ownership and escrow issues be researched to better understand the property ownership and easement conditions along the daylight channel proposed alignment.

2.4.3 Existing Marsh Discharge to Puget Sound

At the downstream end of the Willow Creek channel adjacent to the Unocal property and the BNSF railroad tracks, there is an embankment spanning the channel with two pipes that have flow control gates. The easterly pipe is a 36-inch corrugated metal pipe (CMP) with a circular slide gate that was partially closed as shown on the Perteet survey sheet (Perteet, 2012). The second, westerly pipe is a 22-inch steel pipe that was fully closed as shown on the Perteet survey sheet, and may leak due to corrosion (Perteet, 2012). The current ownership of these pipes and gates, although located on Unocal property, is being evaluated. These pipes and gates, if they remain closed, can severely limit the amount of tidal flow into the marsh and drainage from the marsh. This study strongly recommends that the City's coordination and operation of the gates be more fully understood and considered. It may be the case that these gates are kept closed most of the time, and they could be contributing to the flooding of SR 104 by backing up the entire Willow Creek system. We recommend the City coordinate with Chevron to understand ownership and operation of these gates on the Unocal property.

Willow Creek then discharges westward through two 42-inch concrete pipes beneath the BNSF railway into a small pond between the railway and Admiral Way (Photographs 9 and 10). Willow Creek then enters the City storm vault I.D. 2401. The creek discharges into a 48-inch corrugated metal pipe (CMP) that flows 600 feet southwest along Admiral Way and the BNSF railway south, towards Marina Park. This section of pipe is owned by the Port of Edmonds who charges the City a fee for its use. If the pipe is abandoned, the City may need to renegotiate the fees pertaining to this pipe. The pipe has been reported as aging and is in need of replacement, and likely contributes to the significant hydraulic losses and reduction in upstream tidal prism inflow and drainage (Shuster, 2012).

At the northeast corner of the Marina Park, parking lot, the corrugated metal pipe connects with the City of Edmonds storm vault I.D. 2457 with the 48-inch, top-hinge steel tidegate leading to a 48-inch high-density polyethylene (HDPE) pipe (Photograph 11). The City of Edmonds stormwater department operates the gate for flood protection between late October and early March allowing the tidegate to open and close normally. From early March to late October, the City uses a truck and hoists open the flapgate at a 90 degree angle to the flow line. The City has reported that when in normal operation (fall/winter period) the gate closes, but is not watertight (Moles, 2012).

The tidegate vault then discharges south into the 48-inch HDPE pipe into a second vault located approximately 50 feet south near the Marina Park grassy area between the parking lots. This pipe outfall system was recently constructed in 2004 and extends approximately 1,000 feet to the west and discharges offshore into Puget Sound at an approximate elevation of -9.0 feet (NAVD88) (Photograph 12) (Appendix C). The outfall is quite deep and is a poor attractant and entrance for fish.

The Marina Beach Park and pipe outfall are located in an area that is part of the historical sand spit at Point Edward (Photograph 13). The site lies at the northern end of a 5-mile-long drift cell, identified as SN-3 (U.S. Geological Survey [USGS], 2010). This drift cell collects and transports sediment from feeder bluffs and stream deltas along the Puget Sound shoreline. Sediment is transported from as far south as Shoreline, Washington, whereby wind and wave action act in a northerly direction moving sediment along the shoreline to the Edmonds Point area.

Other elements of the Marina Beach Park include the BNSF Railway, Sound Transit bridges located just east of the off-leash dog park area gate entrance (Photograph 14). These bridges are a great benefit to the Willow Creek Daylight project, and were pre-constructed with the intent of the Willow Creek Daylight alignment through this location. The two bridges are for the current track and the proposed second track. The off-leash area and the south parking lot, and the treed and grassy knoll area are discussed further as part of the future park studies and possible daylight channel realignment locations (Photographs 15 - 17).

2.4.4 Tidal and Stream Hydrology Data Collection

In support of the study objectives, tidal hydrology, water surface elevations, temperature, and salinity were collected for the project from September 2012 through March 2013. The data-collection period will extend through June 2013, and the data will be presented in a separate data report. The LTC-1 data logger is located in Edmonds Marina (Photograph 18). The LTC-2 data logger is located in the Willow Creek channelized section of the stream (Photograph 4). The Shellabarger Creek LTC-3 data logger is located just north of SR 104 near the culvert crossing (Photograph 2). Tidal hydrology data are summarized in Figures 6 through 8. Data collected indicates that the water elevations in Willow Creek are “muted” and less than the tide. This is a result of the operation of the tidegate and losses through the Port of Edmonds CMP stormwater pipe system, and the partially closed pipes and gates at the downstream end of the existing Willow Creek channel. Daylighting the channel will likely affect the Willow Creek flow and water surface elevations, and is discussed further in the preferred restoration alternative. The data indicate that Shellabarger Creek marsh is disconnected and does not fully drain into the Edmonds Marsh, likely resulting from thick cattails and clogged culverts. This lack of drainage connection likely contributes to stormwater flooding of SR 104. Also, the data indicate that Shellabarger Creek is primarily freshwater and does not mix with the incoming tidal inflows. This is likely as a result of the thicket of cattails impeding flow exchange in the marsh. Finally, the Willow Creek LTC-2 data logger shows high spikes in temperature above 16 degrees Celsius in September. This is above the lethal limit for salmonids, and is likely a result of poor vegetative cover along the channel.

In working in tidal systems, it is important to document the project survey data. For the purposes of this study, the project vertical datum is the North American Vertical Datum of 1988 (NAVD88). Elevations in tidal environments (and from NOAA tidal stations) are often reported in mean lower low water (MLLW) datum. A vertical transformation of -2.09 feet was calculated using NOAA's VDatum v3.1 computer program (NOAA, 2012). The project elevations can be determined as follows:

MLLW Datum Elevation – 2.09 feet = NAVD88 Elevation

As an example, the MLLW elevation (MLLW datum) of 0.0 feet would be an elevation of -2.09 feet for the MLLW elevation (NAVD88).

The tidal range at Edmonds is approximately 11 feet between mean lower low and mean higher high tides. The mean higher high water (MHHW) for the National Oceanic and Atmospheric Administration (NOAA) tidal station 9447130 is 9.3 feet (NAVD88).

2.5 Existing Fish Habitat Conditions

The fish community that has been documented utilizing existing habitats in the Edmonds Marsh and contributing creeks is comprised of coho salmon adults, an occasional chum salmon adult, resident and sea-run cutthroat trout, three spined stickleback, and sculpin (Pentec, 1998; WSDOT, 2004; O'Connell and others, 2009). The Willow Creek Hatchery historically raised coho salmon and Chinook salmon with annual releases of between 2,000 to 8,000 coho fry into Willow Creek (Pentec, 1998). More recently, the hatchery produces only coho fry, but none are intentionally released into the creek (WSDOT, 2004; Thompson, pers. comm., 2012). Low numbers of juvenile coho salmon have been observed in Willow Creek in 2012 (Rice, pers. comm.; Schlenger, pers. obs.). Prior to the early 2000s, it was estimated that approximately 20 to 40 adult coho salmon returned to the creek each year (WSDOT, 2004). However, more recently, no adult coho salmon have been observed in Willow Creek (Thompson, pers. comm., 2012). The following paragraphs describe existing habitat conditions for fish, in particular salmonids, in Edmonds Marsh starting from downstream and moving upstream through the marsh to Willow and Shellabarger Creeks.

2.5.1 Connectivity to Puget Sound

The fish habitat conditions in Edmonds Marsh are strongly influenced by the restrictions to the connectivity of the marsh to Puget Sound, as well as the development that has occurred in the surrounding watersheds. A primary consideration in characterizing fish habitat in the marsh is the blockage of fish movement between the marsh and Puget Sound that the pipe and culvert system poses. Available information indicates that until recent years, a small number of adult coho salmon and an occasional adult chum salmon or sea-run cutthroat trout will locate the outlet pipe in the lower intertidal zone and migrate upstream through the approximately 1,600 feet of the pipe and channel to enter the marsh system (Stay, pers. comm., 1995) as reported in Pentec (1998) (Thompson, pers. comm., 2012). Other salmonid life stages and other fish species are not known to enter the marsh from Puget Sound.

Aerial photographs and other mapping sources show macro-algae and eel grass beds near the beach shoreline (WSDOT, 2004) and the beach areas may provide forage fish, surf-smelt spawning habitat (PSNP, 2005). These conditions would indicate forage fish availability and habitat for both juvenile and adult salmonids. Future study phases should confirm nearshore macro-algae, eelgrass, and forage fish spawning conditions on the beach and nearshore area as it relates to habitat conditions, environmental documentation, and permitting.

Salmonids migrating upstream into the marsh, after exiting the pipe from the low intertidal zone to the railroad tracks, encounter the 700-foot-long confined channel that leads to the marsh. Since the mid-2000s, no adult salmonids have been documented entering the creek and migrating all the way to the Willow Creek hatchery (Thompson, pers. comm., 2012). It is possible that low numbers of adult salmonids have entered the marsh during this time, but not migrated up to Willow Creek. The straight channel that upstream migrating fish encounter after migrating up the outlet pipe is poor habitat for salmonids as it offers no instream structure or overhanging riparian vegetation. WSDOT (2004) described the confined channel bottom as having “exclusively muck and the water is uniformly shallow, warm, and exposed.” Shannon & Wilson field staff observed a sandy, gravelly substrate with occasional gravels in the confined channel in summer 2012. The change in conditions is likely related to the Unocal sediment remediation activities in along the channel.

We found no current documentation of current juvenile Chinook salmonid habitat use in the marsh.

2.5.2 Existing Marsh Habitat Conditions

In the main body of Edmonds Marsh, habitat conditions range from freshwater to brackish. The extent of saltwater inundation, the vegetation communities along the salinity gradient, and the overall shape of the marsh are controlled by the tidal exchange through the tide gate and stormwater pipe system, the inputs of freshwater from the surrounding watershed, and the development that has encroached on the marsh’s historic footprint of nearly 100 acres. The marsh includes a distinctly estuarine area extending across approximately the western third of the marsh and a freshwater wetland in the remaining areas. Although there is a gradient in the salt tolerance of plants within the estuarine portion, there is a fairly abrupt transition between the estuarine and freshwater portions of the marsh.

The estuarine portion of the marsh supports a variety of native plant species in higher salinity areas (e.g., seashore saltgrass and pickleweed) to lower salinity areas (e.g., saltmarsh bulrush and Lyngby's sedge) (Pentec, 1998). The more salt- tolerant plant species occur primarily along the drainage channels in the estuarine portion of the marsh (O'Connell and others, 2009). Pentec (1998) reported that the high tide elevations in the marsh are lower than those documented in nearby shoreline areas with unrestricted tidal exchange due to tidal muting. As a result, the distribution of estuarine emergent plants in the marsh is limited to tidal elevations that are lower than observed in other comparable salt marshes in Puget Sound (Pentec, 1998). The estuarine portion of the marsh includes unvegetated areas and shallow tidal channels, as well as an open channel along the margin of the Unocal property to the south of the marsh. The remaining two-thirds of the marsh area on both sides of SR 104 support freshwater vegetation. Dense growth of cattail vegetation, along with purple loosestrife and climbing nightshade are reported (Pentec, 1998). Purple loosestrife has now been nearly extirpated from the area due to biological controls and removal activities.

Recent surveys of the marsh show that there are no direct channels connecting the streams with the saltwater tidal channel sections of the marsh (Perteet, 2012). As a result, there is no channel route for fish to move between the creeks and the estuarine marsh. This may be related to the recent lack of reports documenting coho adult migration upstream into Willow Creek. Furthermore, filling of drainage channels in the freshwater wetland due to siltation from the upper watershed has limited saltwater inundation and enabled the freshwater marsh to expand to the west (City of Edmonds, 2008).

Pentec (1998) characterized the fish habitat in the estuarine portion of the marsh as "marginal to fair rearing habitat" citing the lack of instream structure (along the channelized section of the stream) and marginal water quality in summer months (due to high water temperatures). The estuarine portion of the marsh area provides some rearing habitat for juvenile salmonids and other small fish that are able to survive in saltwater. In considering the quality of the habitat, the availability of prey items for fish is an important consideration and the estuarine portions of Edmonds Marsh can be expected to produce an abundance of prey items because salt marshes are typically highly productive habitats. During high tide, the marsh provides habitat for fish to move throughout the inundation area. During low tide, the marsh drains until only the tidal channels, the channel along the Unocal property, and marsh outlet channel are available, with shallow upstream channels along Willow and Shellabarger Creeks. WSDOT (2004) characterized the open channel habitats between the marsh outlet and the upper extent of the Unocal property as “poor” or “very poor” habitat.

Fish access to much of the freshwater portions of the marsh appears limited, except in the approximately 600-foot-long, historical Willow Creek channel along the southern margin of the marsh. This channel is not currently fully connected with the confluence of Willow and Shellabarger Creeks due sedimentation and establishment of freshwater cattails in the upper marsh. In the area near the confluence of the creeks, the channel is “highly braided and difficult to follow as it filters through thick cattail intertwined with purple loosestrife and climbing nightshade” (Pentec, 1998). Water depths vary substantially in this area, ranging from a few inches to more than 4 feet (Pentec, 1998). As noted previously, there is currently not a channel to allow fish to move between the creeks and the estuarine portion of the marsh. Pentec (1998) characterized the fish habitat in this portion of the marsh as suitable for winter and spring rearing by salmonids, but with potential water quality limitations in the summer due to high water temperatures and low dissolved oxygen.

2.5.3 Upstream Creek Channels

Upstream of the marsh, Willow and Shellabarger Creeks are small creeks that provide some habitats suitable for fish rearing and spawning for at least several hundred feet until obstructions block further upstream fish passage. Pentec (1998) characterizes Shellabarger Creek fish habitat as “fair to good” for rearing and “good spawning potential for salmonids.” In Willow Creek, fish habitat was characterized as excellent for rearing (Pentec, 1998), but interpretations of spawning habitat availability differ as Pentec (1998) characterizes the habitat as “poor” and WSDOT (2004) described the creek as providing “fair to good” spawning habitat.

2.5.4 Contaminant and Pollutant Impacts to Habitat

In addition to the preceding description of primarily physical and biological features comprising existing fish habitat conditions, consideration of potential stormwater pollutants and chemical contamination of water or sediments is necessary.

Stormwater pollutants may enter the marsh from the various sources described above, such as Willow Creek, Shellabarger Creek, WSDOT Edmonds Way manhole overflow, Edmonds Point, Harbor Square and other smaller stormwater sources. To date, there is little to no water quality data for the marsh characterizing stormwater quality from these various sources. Additional data collection of water and sediment quality from Shellabarger and Willow Creeks, and the interior areas of Edmonds Marsh is recommended.

Sediment contamination in Willow Creek has been documented, remediated and for the most part is considered clean by Ecology and Unocal. Sediment contamination and data collection has not been performed along the central and interior areas of Edmonds Marsh.

e and pollutant transport pathways

Contaminants and pollutants could affect the productivity of the marsh habitats. The contaminants (and some pollutants) pose a risk for creating a contaminated prey base, which could bioaccumulate in fish. Ecology has confirmed that sediment remediation in Willow Creek does not indicate potential for bioaccumulation and bio-assessments. However, there is little to no sediment quality information for the interior areas of the marsh, and the Unocal site has some residual groundwater contamination that needs to be addressed. Thus, the quality of fish habitat within the marsh should be considered impaired to some degree by contaminants and pollutants until is the Unocal site cleanup plan is complete and other data and sampling in the marsh are performed and site conditions are better understood in the marsh. That said, preliminary indications are that the Unocal site has completed a significant amount of remediation and cleanup, and is progressing towards cleanup approval of the lower yard with Ecology.

The amount of potential effects on fish is unknown at this time, and is not considered in this current early feasibility study. Potential contamination mitigation measures including cleanup of contaminated soils excavated for the daylight channel, or isolation of the site using geotextile liners, may be required. Studies to further develop data and understanding of contaminated soils and stormwater pollutants are planned for future phases of the project.

Overall, the fish habitat conditions in Edmonds Marsh and the contributing tributaries are “fair” with a great deal of improvement possible through completion of remediation activities, and upstream stormwater management and restoration actions.

3.0 DAYLIGHT ALTERNATIVE ALIGNMENTS

Three alternative alignments have been identified to discharge Willow Creek from the tidal marsh into the Sound (Figure 1). These alternatives were identified in previous studies (Pentec, 1998), and also for this study as potential locations to daylight and realign Willow Creek. All three alternatives involve daylighting either portions of, or the entire, creek channel downstream of the marsh and increasing the tidal connection to Puget Sound. Daylighting in this context is referred to as realigning the creek from a pipe into an open channel. All alternatives will need to cross the BNSF railroad tracks and go through property owned by either the Port, the City, or both. Alternative 1 also involves the Unocal property which has an escrow purchase agreement with WSDOT for the entire lower yard site. The following sections describe the alternatives evaluation approach and findings in detail.

The screening analysis evaluates each of the three proposed alternatives through a qualitative review of habitat modifications and impacts; coastal hydrodynamics; and a compilation of engineering, infrastructure, and property issues. The primary evaluation components of the screening analysis include fish habitat and biological response, using a set of technical criteria developed specifically for the project, and a pros/cons analysis of coastal/tidal hydrodynamics and sediment transport conditions, infrastructure constraints, drainage effects, potential costs, and social-political factors for the alternatives.

A key step in the assessment includes the evaluation of the likelihood of juvenile Chinook and other salmonids to use and access into the daylighted alternative alignments. The following biological response criteria and definitions were used in the screening analysis.

- **Likelihood of juvenile Chinook salmon encountering the marsh outlet**
  - *Explanation of Criterion:* This criterion is a qualitative assessment of the likelihood of juvenile Chinook moving in close proximity to the shoreline of each marsh outlet alignment.
- **Likelihood of the marsh outlet connection remaining open and accessible for juvenile Chinook salmon**
  - *Explanation of Criterion:* Qualitatively assess the potential for sediment transport and/or large wood accumulations to block the access channel to the marsh for juvenile Chinook during the spring and early summer outmigration timeframe.
- **Suitability of marsh outlet and channel for juvenile Chinook salmon passage into restored marsh**
  - *Explanation of Criterion:* Consider the marsh outlet features and their affect on juvenile Chinook salmon's ability or willingness to migrate into the marsh. Considerations include access channel length, generally anticipated flow velocity conditions throughout tidal cycle, number/length of overwater structures (or remaining culvert reaches), and potential habitat features within access channel.
- **Potential to integrate with future restoration**
  - *Explanation of Criterion:* Assess whether the marsh outlet would accommodate potential future restoration opportunities along the outlet channel and in the vicinity of the marsh outlet.

A second component of the screening analysis includes a review of coastal and tidal hydrodynamics in the context of maintaining a permanent connection between Edmonds Marsh and Puget Sound. This review includes a qualitative coastal engineering discussion of tidal hydrodynamics, future marsh conditions, local sediment transport, deposition, and shoaling effects on the alternatives.

The third component of the screening analysis focuses on engineering, property, and socio-political issues. These include a qualitative discussion of infrastructure constraints, drainage effects, potential costs, landowner willingness, and social-political factors for the alternatives from a hydraulic/civil engineering perspective.

3.1 Alignment Alternative 1 – Edmonds Marina Beach Park

Daylighting Willow Creek at the Edmonds Marina Beach Park would involve constructing a new channel across the beach park area from the BNSF railway. Depending on the alignment, the length of the park beach channel would vary from 350 feet if located in the dog park area to the south, or up to 700 feet if located north through the existing parking lot and grassy areas of the park. Appropriate habitat features would be included to make the channel both biologically functional and aesthetically pleasing to park users. For example, instream wood, step pools, and riparian vegetation would improve flow complexity and cover conditions in the channel. Currently, the City is considering the daylight alignment as part of a separate park master planning study.

At the BNSF railway, the daylighted creek would cross under the railroad embankment through a pair of two bridges. These bridges were installed as an agreement between BNSF and Sound Transit, and federal and local resource agencies for Sound Transit's plans for a third rail improvements between Seattle and Everett. The plan involves loss of wetland and streams filled as a result of the Third Rail Easement Improvements (Appendix C). The two bridges were installed by BNSF as part of this agreement in 2010(Photograph 6). Again, these bridges were built and paid for by others, are a valuable benefit to the daylighting project, and are cost that would need to be considered for the other alignment alternatives 2 and 3. As-builts for the bridge installations have been provided by BNSF; however, supporting bridge flow and scour design information for the daylight flow alignment has not been obtained at this time (Appendix C). Additional research and coordination with BNSF, Sound Transit, and WSDOT would be required to determine the structural and hydraulic sufficiency of the existing structure. If not adequately designed, retrofit and modification may be necessary.

Upstream from the BNSF bridges, Willow Creek would be daylighted. The exact configuration of the daylight channel is unknown. In its simplest form, the channel would be 700 feet long flowing straight next to the BNSF railway and on the Unocal property. CH2M Hill proposed a meandering alignment, as part of the Edmonds Crossing Final Environmental Impact Statement (WSDOT, 2004), that flows east away from the railway onto the Unocal property, and connecting with the downstream channelized stream near the current stormwater detention pond. For the purposes of this study, we evaluated a straight channel daylighting on the beach, passing underneath the railroad, and then following a relatively straight alignment to the existing confined channel. The plan form configuration of the channel may be revised in later phases of feasibility and design work, depending upon the availability of the Unocal property for realignment.

3.1.1 Alternative 1 – Fisheries

Improving the connection of Edmonds Marsh to Puget Sound by an outlet alignment through the Edmonds Marina Beach Park offers a great deal of potential for fish movement between Puget Sound and the marsh, including juvenile Chinook salmon and adult salmonids such as coho salmon, sea-run cutthroat trout, and possibly chum salmon. The large marsh can provide favorable rearing conditions for migrating juvenile salmon and promote rapid fish growth, which improves likelihood of survival to adulthood.

In this alignment, the marsh outlet would be located in a small beach area which already is a favorable location for fish because it is one of the more natural beach areas along this stretch of Central Puget Sound. Much of the Central Puget Sound shoreline is armored with protective riprap. Juvenile Chinook salmon tend to remain in close association with the shoreline during their early marine life stage before moving into deeper water and eventually migrating to the ocean (Fresh, 2006). The Edmonds Marsh outlet would be between approximately 8 and 15 miles from the closest Chinook salmon bearing rivers, the Cedar River via Lake Washington Ship Canal, and the Snohomish River, respectively. Given these distances, the marsh may not be as heavily used as it would if it were closer to one of the major rivers; however, some juvenile Chinook salmon do remain in close proximity to the shoreline over long distances in Puget Sound. Several studies of juvenile Chinook salmon distributions in the Puget Sound nearshore have documented the fishes' use of shoreline habitats such as the Marina Beach Park at far distances from their river of origin (e.g., Brennan and others, 2004; Dorn and Best, 2005; Fresh and others, 2006; Beamer and Fresh, 2012). It is likely that juvenile Chinook salmon would locate and utilize the marsh, particularly given this alignment alternative, which would position the marsh outlet along a sandy beach that provides favorable foraging habitat for the fish. It is reasonable to conclude that more juvenile Chinook salmon would encounter the marsh outlet at the Marina Beach Park compared to the alternative alignment through the marina (See Alternative 2 discussion). For adult salmonids returning to Puget Sound, the marsh outlet in the Marina Beach Park is more likely to be encountered compared to the likelihood of the adults entering the marina. There is higher potential for the fish to detect the odor of the freshwater source from a greater distance if it flows across the beach rather than into a marina which has a variety of boating related discharges.

A marsh outlet in the Marina Beach Park would be exposed to the wind and wave conditions of Central Puget Sound and, depending on the outlet configuration, some shifting of the outlet should be expected. As long as the design does not detrimentally impact expected adjacent park uses, such movement of the outlet channel across the beach face is a favorable condition such as naturally occurs at other marshes and tributary outlets. Currently, the upper beach accumulates drift logs that come and go with storm events. Beach logs, as well as shifting beach sediments, may partially impede access to the marsh during some time periods, but it is expected that the force of outflows from the marsh will maintain migratory routes for juvenile Chinook salmon and adult salmonids to move between Puget Sound and the marsh.

Fish locating the marsh outlet will need to swim several hundred feet from the beach to the marsh. The alternative includes a short portion of overwater structure as the channel runs under the BNSF railroad track, otherwise the access channel would be entirely open with the opportunity for habitat features to be included in the design to provide favorable in-channel conditions. Juvenile Chinook salmon and adult salmonids can be expected to migrate this distance to access the marsh habitat. The short distance of overwater structure would not be expected to markedly affect the likelihood of fish entering the marsh entrance channel. The habitat conditions in the entrance channel can be improved by including instream wood, pools, and riparian vegetation.

The Marina Beach Park outlet channel realignment could support future restoration of property along the former Unocal site, east of the BNSF railway. The restored marsh entrance channel could potentially be expanded in size and/or realigned further to the east. The rationale for these modifications is related to the fact that a straight daylight alignment along the BNSF right of way will have sharp turns at the bridges, which can be problematic from a hydraulics and fish passage perspective. Also, expansion or realignment to the east would allow for developing a meandering channel planform more similar to natural channels, and allow for native riparian plantings on both sides of the channel. This would require that at some point in the future some of the former Unocal site property becomes available and suitable for habitat restoration. This would reduce some of the problems identified with the BNSF railway culvert crossing configuration being perpendicular to the tracks. There are no plans for such expanded restoration at this time and possible contamination of soils in the former site may limit potential inclusion of channel restoration and realignment in this area.

3.1.2 Alternative 1 – Coastal Hydrodynamics

Alternative 1, which includes the alignment through the Marina Beach Park, is the only alternative that does not require the connection between Puget Sound and the marsh to be placed (at least partially) through pipes or culverts. The use of open channels for nearly the entire alignment (except for the BNSF railway bridges) will allow for larger volumes of natural tidal prism exchange and marsh inundation (both filling and draining) of the marsh compared to the other proposed alternatives. The proposed outlet, as mentioned above, is located along a relatively natural, nearshore reach with minimal shoreline armoring. The connection can, therefore, be designed as a continuous sloping channel from the marsh down to lowest tidal elevations at Puget Sound. This mimics the type of channel that historically existed connecting the nearshore area with the marsh; although the historic location of the outlet is to the north of the location proposed as part of Alternative 1. The channel could be designed as a relatively unconfined inlet to the marsh or could be designed as an engineered channel to better control in-channel velocities and minimize movement of the channel location due to nearshore processes depending on park maintenance requirements. Littoral transport along the shoreline in this area is from the south to the north (USGS, 2010). The shoreline to the south is armored; however, there is a local source of sediment to the system from Deer Creek that discharges one mile south of the proposed outlet. The natural drift process has the potential to deposit sediments in the proposed outlet channel during extended periods of low flow from the upstream marsh to the beach. This may result in some limited access to the channel for fish at lower tides during portions of the year. However, it is anticipated that higher flows from the marsh, as well as coastal storm events, would have the ability to flush a majority of the deposited sediment out of the channel. The orientation and sediment dynamics of the Willow Creek outlet on the beach should be studied further if this alignment is selected.

This site is subject to direct impact from storm waves from the west and southwest. Depending on the tide level at the time of the storm event, these impacts could include erosion of nearshore sediments at the mouth of the creek, transport, and deposition causing infilling of the mouth of the creek by deposition in the channel, and/or lateral migration and changes in channel location and or depth of the mouth of the creek due to these sediment movements.

The proposed outlet for Alternative 1 has the potential to be the most natural of the proposed alternatives, based on historical understanding of the marsh outlet. In addition, there are opportunities to enhance nearshore restoration activities at the Marina Beach Park mouth that would benefit the marsh restoration project and provide additional nearshore fish habitat.

3.1.3 Alternative 1 – Engineering, Infrastructure, and Property

The Alternative 1 daylight mouth originates in the Marina Park, travels through the BNSF railway, and then northward along the BNSF railway on the Unocal property. As such, there are various infrastructure and property ownership considerations for this alignment.

Within the park, a southern alignment would need to address the existing dog park facilities (Photograph 8). As dogs and a freshwater salmon habitat may not be compatible features, exclusion fencing and vegetation screening may be necessary to protect and shelter fish from external stimulus and allow the fish to migrate through the dog park area. Adjacent to the northern edge of the dog park is a gravel parking lot, which may be impacted if geotechnical bank reinforcement, shoring walls, or earthwork grading encroaches into the parking area (Photograph 9).

A northern channel alignment through the park would need to address potential loss of parking spaces and grass landscape areas, and stormwater infrastructure conflicts. The alignment would cross the park access road and parking spaces, and likely flow through the grassy "knoll" and onto the beach at the north (Photographs 10 and 11). This general alignment is near the existing Willow Creek stormwater outfall pipe alignment, as well as other underground utilities. A northern alignment could become a natural setting for the stream restoration, but could potentially involve significant changes in the park landscape and uses, which would translate into additional project costs. Additional evaluation of both a southern and northern channel alignment would need to be conducted as part of a future park planning study, if this alternative is chosen.

At the upstream end of the park, the stream would flow under the pre-constructed BNSF bridges. The stream crossing through the existing culverts is perpendicular to the tracks and may have an abrupt change in flow direction due to turning the corner and crossing underneath the railway. This configuration is not an optimal alignment for Willow Creek daylight restoration, unless space can be provided for the transition associated with the proposed channel approaches. Also, the bridge widths may not meet current fish passage design guidelines for no-slope or stream simulation widths (WDFW, 2003). Options for improvement include modifications to the existing channel alignment, or looking at channel meander patterns and approach directions both upstream and downstream from the bridge that allow room for transitioning the channel through the bridge. It is not known if the current bridges subgrades and foundations were designed and constructed to protect the BNSF railway from the future scour conditions from a daylighted channel. A bridge hydraulics and design report has not been identified at this time. It is noted that this structure may need to increase in width (to the east) if BNSF expands the second rail line through the Edmonds area.

Known utilities for Alignment 1 include the City stormwater pipeline, nearby water and sewer lines crossings to the north, and a buried communication lines beneath the BNSF railway. A full investigation of utility locations and survey is needed for final design.

Property ownership for Alignment 1 is limited to the City, BNSF, Unocal, and WSDOT. The park area and the marsh are owned by the City, the bridges and railroad right of way by BNSF, and the upstream daylight channel would most likely be located on Unocal property.

In summary, Alternative 1 would include a new channel excavation downstream from the current confined channel between the BNSF and Unocal property, for which contaminated soils remain a concern. There are additional restoration opportunities to the east on the Unocal property, if the owner is amenable, which also have similar contamination potential. The existing BNSF bridges are a great benefit to the daylight project. Any other alternative would require the additional cost of a new bridge or culvert crossing the railroad. The one downside from the bridges is that the crossing alignment may not be ideal due to the abrupt angles through the bridge opening.. Research and gathering engineering reports and plans for the bridge crossing would be helpful. The bridge alignment needs to be considered in evaluation of the two Marina Beach Park proposed alignments. The Marina Beach Park realignment(s) have infrastructure such as stormwater pipes, water supply pipelines, and parking areas that need consideration, for which we recommend a park planning study.

3.2 Alignment Alternative 2 – Port of Edmonds Dock F

The Port of Edmonds Dock F alternative alignment would divert the stream towards the north into an existing storm drainage pipe alignment, and then cross Admiral Way to the west through the Edmonds Marina parking lot (Figure 1). The estimated length of this realignment from the Marsh to the waterline in the marina is 400 feet. In the 1998 report for the Port of Edmonds, Pentec (1998) describes a possible open channel configuration as:

"…a slightly sinuous open channel into the marina between existing Slips F and G, a lineal distance of approximately 275 ft. Appropriate in-channel structures could be installed to make the channel both biologically functional and aesthetically pleasing to the Edmonds community. For example, a series of step pools with appropriate spacing would facilitate fish access over potentially prohibitive low-tide gradients, while providing nice stream habitat for public enjoyment."

This alignment would include keeping the existing piping under the railroad tracks and modifying storm drainage piping along and underneath Admiral Way, and would have a daylighted channel through the existing marina parking lot. The discharge location would be inside the existing marina between Docks F and G (Photograph 7).

3.2.1 Alignment Alternative 2 – Fisheries

Like Alternative 1, an Edmonds Marsh outlet alignment through the Edmonds Marina would offer a great deal of potential for fish movement between Puget Sound and the marsh, including juvenile Chinook salmon. The marsh would be a productive habitat for fish entering the system. With a marsh outlet in the marina, somewhat fewer juvenile Chinook salmon would be expected to encounter the marsh entrance than an outlet to the beaches north or south of the marina (Alternatives 1 and 3, respectively). Not all fish are expected to enter the marina as they navigate past it, and there are few if any forage areas in the marina. This expectation stems from the fact that the marina is a partial obstruction to juvenile Chinook salmon that tend to migrate along shallow portions of the shoreline and avoid deep water (until they grow larger).

The marina requires the fish to swim around the outside of the marina and either cross the deep water marina entrance or enter the marina. Juvenile Chinook salmon migrating from south to north would be expected to encounter the marsh outlet if it was located in the Marina Beach Park. A marsh outlet in the marina may not be encountered by as many fish because some may not enter the marina as they navigate around the outside of it. Those fish that enter the marina would encounter poor habitat conditions including extensive overwater coverage, deeper water, modified shoreline within the marina, and potential exposure to chemical contaminants (petroleum), and boat and marina noise. These conditions affect the foraging opportunities, prey base quality, as well as increase predation risks.

A marsh outlet in the marina would need to be a highly engineered channel and culvert that is fixed in place to maintain and protect existing marina infrastructure. The channel would be designed to provide suitable depth and velocity conditions to enable fish to move between

Puget Sound and the marsh. Due to the fixed position of the outlet and the anticipated design to provide suitable flow conditions for access, this marsh outlet is more certain to remain open and accessible to juvenile Chinook salmon and adult salmonids that encounter it. Any step pool feature to provide access to the channel during low tides would be more accessible to adult salmonids than it would for juveniles. A marsh outlet alignment through the marina would also provide the shortest access channel distance to the marsh, which implies improved fish access to the marsh. However, this alternative requires a hardened channel and pipe system, which offsets potential gains from a shorter system. There are no clear advantages to fish habitat for the marina location.

3.2.2 Alignment Alternative 2 – Coastal Hydrodynamics

Alternative 2, which includes the alignment through what is now a parking lot and into the existing marina basin, would consist of an engineered hardened channel outlet into the marina with an upstream pipe or culvert connections to the marsh due to site constraints (as discussed above). The use of pipes and culverts within the channel system between the marsh and the sound will result in some attenuation of the tide into the marsh, as well as some delay in draining of the marsh system during periods of low tide. The proposed outlet would be through what is now a parking area and would terminate within the marina directly into relatively deep water. Therefore, the channel would need to be graded in such a way to ensure the mouth of the creek is below MLLW or the outlet of the creek may be perched above lower tidal levels due to the lack of an intertidal beach area (low tide bench) at the proposed outlet to support a low tide channel. This would result in higher than desired in-channel velocities during low tides which could be an access problem for fish into the marsh, during the low tide conditions.

Littoral transport along the shoreline in this area is designated as “no appreciable drift” (USGS, 2010), which means that there is either little to no sediment drift at this location or there is no appreciable net drift (however, there could be gross transport north and south during different times of the year). At the location of the proposed outlet for Alternative 2, there is most likely little to no shoreline sediment transport due to the presence of two breakwaters which shelter the marina from waves. However, there would likely be sediment transport and deposition that would occur from upstream marsh sediment supplies. This additional sediment transport into the marina is undesirable and would increase maintenance dredging requirements for the marina. It is not likely that the amount of sedimentation would block the channel, rather, the rate of sedimentation in the marina would increase, thereby requiring more frequent marina dredging.

3.2.3 Alignment Alternative 2 – Engineering, Infrastructure, and Property

The Alternative 2 daylight outlet in the marina is located within an array of infrastructure. Infrastructure includes buildings, walls, piles, stormwater pipelines, sewer, water supply, electrical (possibly gas), car parking, and boat docking areas. This amount of infrastructure would likely require a significant amount of engineering design, as well as coordination and protection of infrastructure during construction. Additionally, construction would likely occur during the busiest times at the marina, and could impact marina operations. The amount of adjacent infrastructure implies a rather large cost for installation of a new daylight channel. Also, the daylighted channel (if not in a pipe) would eliminate a number of parking spaces for the port and marina.

Bob McChesney of the Port of Edmonds was contacted during coordination activities for installation of the project data logger in the marina. At that time, he was asked about the viability of daylight channel exiting into the marina between Docks “F” and “G.” His response was firmly that the Port did not support a Willow Creek daylight alternative with an outlet into the marina (B. McChesney pers. comm., August 22, 2012).

Further east, the channel would need to cross beneath Admiral Way, where the road tees and heads east near the Port parking lot. This would require traffic control and coordination during construction, which also implies additional costs.

Upstream of the Admiral Way road culvert crossing, the channel would follow the road. If a stream channel is designed in this area, it would likely encroach upon the parking area to the east. This may be done without impacting parking, but could potential require the removal of existing trees and vegetation.

Finally, the daylight channel would need to cross the BNSF railroad embankment. This will require installation of a new culvert or bridge structure and protection of the railroad embankment, as well as continue to provide rail service during construction. The new culvert or bridges would likely higher costs than a typical roadway bridge or culvert crossing. Construction in the BNSF railway right-of-way (ROW) requires special easements and permits from BNSF, as well as special construction contract specifications for safe-zone working along the railroad. This applies for any alternative where construction through, in, and around the embankment and within the ROW is required.

Property ownership along Alignment 2 is the City, the Port, and BNSF. It is doubtful that a viable agreement could be reached with the Port, considering their stated position on the

Alignment 2 alternative. Alternative 2 alignment is considered a high social-political risk and is not recommended.

3.3 Alternative 3 – Sunset Beach Alignment

The Sunset beach alignment would relocate the outlet of Willow Creek to the northwest corner of the marsh and would approximate the mapped historical outlet (Figure 1*)*. The estimated length of this proposed realignment alternative would be approximately 900 feet. This alignment would require installation of a new culvert or pipe underneath the BNSF railway. The alignment would then run northwest through an open gravel parking lot owned by the Port. We have assumed that a property sale or exchange with the Port is not a viable element of the project for a full daylight channel and, therefore, a nearly 600 foot long pipe would need to be installed underneath the gravel parking lot, or a daylight channel agreed to through the parking lot by the property owner. The pipe would then cross underneath W. Dayton Avenue/Admiral Way and daylight on Sunset Beach between the Edmonds Marina breakwater near the fishing pier access and onto the beach.

3.3.1 Alternative 3 – Fisheries Perspective

Reconnecting Edmonds Marsh through this alignment would offer some potential for fish use of the marsh; however, the extensive channels and lengthy pipe system necessary to connect the beach to the marsh would limit the likelihood that juvenile Chinook salmon and even adult salmonids would enter the system. The extended pipes would have to be designed to provide suitable depth and velocity conditions to allow fish passage; however, fewer fish would be expected to enter compared to an open channel. This is a significant factor limiting the potential benefits associated with this alignment.

The Sunset Beach alignment of the marsh outlet is in a slightly more protected location than the Marina Beach Park alignment because the marina blocks the strong wind and waves from the south. As a result, the Sunset Beach alignment can be expected to have fewer issues with partial outlet closure than the Marina Beach Park. For fish, this means the Sunset Beach alignment would provide clearer access at the mouth for fish moving between Puget Sound and the marsh.

The Sunset Beach location for a marsh outlet would be located in a sand and gravel beach area adjacent to the marina. This is a favorable foraging area along the beach where prey forage fish are found on the beach sands, macroalgae and eel grass beds. Also the marsh outflow would transport prey items to fish along the beach. However, based on the adjacent marina and buildings, the marsh outlet would likely have to be engineered to remain in a fixed position which would limit the opportunity to provide a natural marsh outlet. In this way, the Sunset Beach alignment is more like the marina outlet alternative than the Marina Beach Park alignment.

While the proposed outlet for Alternative 3 has limited spatial extent in the nearshore compared to Alternative 1, there may be some limited opportunities to conduct beach/nearshore restoration activities at the Sunset Beach outlet location, such as placement of large wood debris and native plantings. This would also benefit the marsh restoration project and provide additional nearshore fish habitat.

3.3.2 Alternative 3 – Coastal Hydrodynamics

Alternative 3, which includes a northern outlet alignment through Sunset Beach, would consist of an engineered hardened channel with upstream pipe/culvert connections to the marsh due to site constraints (as discussed above). While the location of the outlet for this alternative coincides with its historical location, as with Alternative 2, the use of pipes/culverts within the channel system between the marsh and the sound will result in some attenuation of the tide into the marsh, as well as some delay in draining of the marsh system during periods of low tide.

The proposed outlet is located along at Sunset Beach; a small intertidal beach area is backed by shoreline armoring above MHHW and adjacent to one of the breakwaters for the marina (located south of the proposed outlet location). The outlet channel can likely be designed as a continuous sloping channel from the marsh down to lowest tidal elevations at Puget Sound; similar to Alternative 1. However, the nearshore area at this location is significantly smaller than that of Alternative 1 due to the physical constraints of the area (adjacent armoring and upland property).

Littoral transport along the shoreline in this area is designated as “no appreciable drift” (USGS, 2010). At the proposed outlet location, the lack of appreciable drift is likely due to the interaction of the site with the large breakwater to the south, which shelters the area from storm waves from the south, southwest, and west, which are the most significant storm directions for this area. There would likely be minor sediment transport and deposition from the marsh. It is more likely that the outlet of this channel will remain open and free of sediment deposition than Alternative 1.

This site is subject to direct impact from storm waves from the northwest and north, but is sheltered from all other storm wave directions. The presence of the breakwater is anticipated to greatly limit the impact of storm waves on the proposed outlet in terms of sediment transport and infilling. However, it is possible that storm events from the north and northwest could impact the site in similar ways (influencing the channel to migrate in one direction or another) as described for Alternative 1.

3.3.1 Alignment Alternative 3 – Engineering, Infrastructure, and Property

The Alternative 3 daylight outlet at Sunset Beach, to the north would encounter a variety of infrastructure and property owners. This alternative alignment most closely represents the historical marsh mouth to the Puget Sound. Significant development and changes to the landscape have occurred in this area.

Immediately upstream (south) of the beach, the daylight channel would encounter Admiral Way or Dayton Street at the corner. This would require a pipeline, and would need to be built around existing stormwater drainage utilities among other existing underground utilities. This pipeline would need to be a significant structure and would likely have associated significant construction costs.

South of the Admiral Way street corner, the stream channel would flow into a partially used gravel lot which is owned by the Port. The channel could daylight through the parking lot, but would require elimination of overflow parking in this area. This lot was under consideration for the Edmonds Crossing project as an alternative alignment for SR 104, but was not identified as a recommended alternative. The Port was not interviewed regarding this alignment.

At the southeastern corner of the lot, the realigned channel would then flow through a culvert or pipe through the BNSF embankment and directly into the marsh. This would likely require construction of bridges or culvert similar to the existing bridge for Alternative 1. The limitations associated with the bridges are similar to those discussed as part of Alternative 2.

Property ownership along Alignment 3 includes the City, the Port, and BNSF. A significant amount of the project is located on Port of Edmonds property. The daylight channel would require a lengthy easement or purchase of the current gravel parking lot area on the corner of Admiral Way and Dayton Street. It is unlikely that a viable agreement could be reached with the Port, considering their stated position on daylight channel realignment on Port property. We would recommend confirming this position with the Port, if Alternative 3 is identified as having merit warranting further investigation.

3.4 Preferred Alignment Recommendation

From a fisheries perspective, all three of the alignments would improve shoreline conditions and expand the saltwater influence in the marsh so it functions more like a natural salt marsh and can provide fish access. The Marina Beach Park alignment is the most beneficial to fish because it provides an open channel connection that can be designed to provide good habitat for fish moving between Puget Sound and Edmonds Marsh. In addition, the marsh outlet into the Marina Beach Park would add a beneficial feature to an area that provides favorable nearshore rearing conditions for juvenile Chinook salmon, especially compared to the extended section of riprapped shoreline to the north and south. The concerns of the Port Dock F alignment are the increasing rearing time in the marina for juvenile Chinook salmon that enter the marina and the extended pipe length the fish must navigate associated with the Sunset Beach alignment. These factors limit the suitability of a Sunset Beach marsh outlet.

From a coastal hydrodynamics perspective, all three of the alignments would provide connectivity between the marsh and Puget Sound, and likely improve tidal inflow and drainage from the marsh. Each alternative has distinctly different littoral drift sediment conditions. Alternative 1 will have design challenges related to littoral drift and sedimentation in the channel that could potentially cause fish access issues at low tides. This, however, is a similar condition observed at other natural stream mouths throughout Puget Sound, and would likely only occur periodically. Alternative 2 would impact maintenance in the Port marina by increasing maintenance dredging. Alternative 3 would require long pipe runs that would be difficult and costly to design for fish passage. Based on these observations, Alternative 1 has the best potential to both improve tidal inflow and drainage from the marsh, while still providing hydraulic conditions conducive to fish passage, relative to Alternatives 2 and 3, which both include lengthy pipes as part of the proposed the alignments.

From engineering design, infrastructure protection, and property ownership perspectives, Alternative 1 requires the least amount of new infrastructure to complete the proposed alternative. Alternative 1 is the only proposed outfall location that has existing BNSF bridges, although additional approach work may be required. Alternatives 2 and 3 would require contending with significant Port, marina, and City roadway and drainage infrastructure, which implies increased costs for construction, easements, property purchases, and negotiations. Based on direct discussions with the Port, they would not support Alternative 2, which would outfall in the Port-owned marina. Alternative 3 has a long alignment through Port property. Acquiring or purchasing an easement could be difficult, which would significantly increase project costs.

In summary, it is our opinion that Alternative 1, realigning the Willow Creek outfall through the Edmonds Marina Beach Park, is the most logical location, given the urban area site and property ownership constraints. This alternative will:

- Provide the best attractants for juvenile salmonids at a natural beach area,
- Allow for potential additional beach restoration benefits,
- Improve saltwater tidal inflow and marsh drainage conditions,
- Has the least amount of existing infrastructure constraints,
- Is located in a position acceptable to the BNSF railway.

Alternative 1 is not without challenges, including:

- Identification and design of a preferred alignment within the park that meets multiple user requirements,
- Potential modifications needed at the pre-constructed BNSF bridges
- Location of the realigned stream adjacent to the Unocal property with known contamination.

The study team recommended the early feasibility study evaluate the Preferred Daylight Plan, Alternative 1 – Edmonds Marina Beach Park alignment. Our findings are presented in the following section of the report.

4.0 PREFERRED DAYLIGHT PLAN

The preferred daylight plan was further evaluated to assess fish habitat and flooding conditions if the daylight channel were built. The following section includes an expanded description of the conceptual daylight design plan, an evaluation of the tidal hydraulics, benefits to fish and potential effects to localized flooding and potential infrastructure impacts (Figure 9).

4.1.1 Marina Beach Park Area

The Marina Beach Park area is the logical outlet of the daylight channel to Puget Sound. The exact alignment and configuration through the park is not known at this time. The City is planning to perform a park planning and public study to finalize the daylight channel alignment. The Marina Beach Park channel daylight alignment will start at the pre-constructed BNSF railroad bridges. From this location, there are two logical directions for the daylight alignment;

- A south alignment through the off-leash dog area
- A north alignment through the park including the south parking lot, and possibly the treed and grassy knoll and beach areas

The park channel alignment will be finalized in future phases of work based on coastal geomorphology, hydrodynamics, sediment and wood processes, to which future park plans will be adapted for the new channel and outfall location. For the purposes of this study, the South Alignment through the dog park was analyzed for fish passage and flood effects (Figure 8).

The conceptual plan includes a gently meandering channel through the off-leash dog area. The conceptual beach outfall channel will flow from the BNSF railway bridges to the MLLW elevation of -2.09 feet. The beach channel would be approximately 350 feet long, with a top width of 50 to 70 feet on the beach and 30 to 40 feet through the bridges. The depth of the channel will vary from 12 feet deep (upstream near the bridges) to 15 feet (downstream).

At the upstream end of the beach channel, the invert of the channel elevation was selected to match the invert shown in the BNSF as-builts provided by the City (BNSF, 2010). The plans show a 38 foot bridge span with 1.5 horizontal to 1 vertical (1.5H:1V) side slopes, protected by rock. The invert of the channel elevation is 4.26 feet. This invert elevation was held at 4.26 feet, and the channel excavated downstream to match the MLLW elevation of -2.09 feet (NAVD88). There is little supporting documentation as to the bridge design hydraulics, erosion, scour, and fish passage conditions. Future studies will need to consider these bridge related factors on the restoration channel.

The channel bed and side slopes (particularly the northern bank) may require grading and stabilization, which is unknown at this time. The proposed channel will also migrate due to the natural sediment shoaling conditions along the shoreline. The bank next to the parking lot and bridges will need scour and erosion protection. A mechanically stabilized, geotextile soil lift and vegetated embankment next to the parking lot is envisioned with rock placement as needed to protect existing infrastructure from excessive erosion and scour.

Dog access to the outfall is likely in conflict with fish habitat restoration, so the dog area and fencing will need to be modified and relocated away from the daylight beach channel. If the dog park area is moved to the south, then a pedestrian and maintenance vehicle bridge will be needed to cross the daylight channel.

The pedestrian and maintenance vehicle bridge will be needed to allow access from the parking lot to the north, to the dog park and beach area to the south. The City Parks and Recreation Department will need to specify the vehicle loads for the bridge. The span of the bridge will match the 38-foot-wide BNSF railroad bridge. The abutments of the pedestrian bridge will likely be founded on piles, and need to have bank erosion and scour protection measures to prevent undermining of the bridge approaches.

It appears that the BNSF bridges have pile foundations but no channel or erosion protection materials were installed at the time of construction. Channel erosion protection will likely be needed from the park pedestrian bridge extending upstream from the BNSF bridges and corner where the daylight channel turns from north-south to northeast-southwest direction. The BNSF bridge designs will also need to consider if BNSF plans an additional rail expansion to the east, a third rail which is unlikely at this time. The Conceptual Design Plan in this report assumes an alignment and geometric configuration of the channel that accommodates the current two-rail rail expansion plans (Figure 9). The costs of a third bridge are assumed to be BNSF's responsibility for future rail expansion, and not included as part of this daylight project.

The northern edge of the dog park, along the south parking lot, is the historical Unocal fuel transfer pier. The study team currently understands that this structure was built on creosote timbers that were filled in and not removed during construction. Excavation, as well as beach channel erosion and migration, may encounter these piles, which may need to be removed and disposed of at a facility that can handle creosote waste. Also, there may be potential oil- and gas-related contaminant in the beach soils and park area. Future studies will test and evaluate if contamination exists in the beach daylight area.

Utility relocates may also be part of the Marina Beach Park daylight alignment. Regardless, other utilities may be encountered in the excavations and should be located in the next phase of design.

Replacement of the existing tidegate using a self-regulating tidegate (SRT) may be necessary. This study considers the tidegate an option at this time. The current tidegate was installed to provide coastal flood protection to the marsh interior areas. Future studies would need to consider the effects and operational criteria of the tidegate, which may be similar to existing operations by the City. Additional discussion of this structure is included in the hydraulics assessment of the preferred plan below.

4.1.2 Daylight Channel Area

The daylight channel is proposed to extend upstream (north) from the existing BNSF railway bridges, running between the BNSF rail and the Unocal property to the open areas of Edmonds Marsh proper. It is assumed, for the purposes of this early feasibility study conceptual design, that the channel will be constructed in a straight alignment, with a length of approximately 750 linear feet. The channel is located primarily on the Unocal property with some encroachment on the BNSF railway ROW. The channel configuration will be an approximate 14-foot-wide bottom width, side slopes of 2H:1V, and a top width of 40 to 50 feet. The profile of the channel is 0.0012 foot/foot. It is assumed that the daylight excavations will encounter some level of petroleum-related, hydrocarbon contamination. Contaminated soil handling and disposal will likely be required. Installation of a geotextile/polyvinyl chloride liner may be necessary along the daylight channel to protect from potential contamination. Coordination with the Unocal property and cleanup study will be necessary. Alternative daylight alignments to the east, further onto the Unocal property, may provide better opportunity for improving the daylight channel alignment through the BNSF railway bridges, and increase riparian plantings. Currently, the existing channel experiences large temperature fluctuations that are not observed in the marsh wetland or tidal beach areas. However, this expansion of the daylight channel realignment location onto the Unocal property remains speculative at this time.

4.1.3 Edmonds Marsh Area

Upstream in the Edmonds Marsh area, the study proposes to excavate tidal channels and reconnect Willow and Shellabarger Creeks. Currently, the channels are filled with sediment. Stream flow disperses through dense cattail vegetation without a direct connecting channel. Optional elements of the conceptual design are removal and mowing of the dense vegetation stands, and native marsh plantings. Increases in salt water inflow will likely reduce the area of cattail growth, but this could take a long period of time and vegetation removal may be desirable. These options will be investigated further in future feasibility and design phases of the project.

4.1.4 Cost Estimate

The preliminary engineer’s opinion of probable cost is approximately $4.35 million (M) with a 30 percent contingency. An additional $1.1M is estimated for feasibility studies, engineering design, and permitting. These costs do not include real estate costs. There are numerous uncertainties in the cost estimate including property ownership and land transfer, contaminated soils conditions and handling and disposal requirements, BNSF railway bridge abutments, and foundation conditions, stormwater inflows and structure protection and realignments, utilities relocations, cultural and archaeological preservation.

5.0 TIDAL HYDRAULICS ASSESSMENT OF THE PREFERRED PLAN

The preferred daylight plan was further evaluated to assess fish habitat and flooding conditions if the daylight channel were built. A tidal hydraulics assessment was performed for existing and proposed conditions to evaluate the effects on project site habitat and flood conditions. A detailed hydraulics report was developed by Anchor QEA and is included in Appendix B (Anchor, 2013).

5.1.1 Tidal Hydraulics Modeling Setup

Modeling efforts included development of a one-dimensional, unsteady flow hydraulic model for both existing and proposed conditions. The models were used to evaluate tidal inundation, water depths, and in-channel velocities for the beach, daylight channel, and marsh, for both existing and future proposed conditions based on typical low flow (tidal) and approximate 100-year flood flow conditions. The model used for the evaluation was HEC-RAS with software developed by the U.S. Army Corps of Engineers Hydrologic Engineering Center River Analysis System (USACE, 2010).

Tidal inflow and elevation data for the model include NOAA tidal data from the Seattle, Elliot Bay Station (NOAA Station 9447130). The tidal data from the Elliot Bay station was compared to the Edmonds Marina station (LTC-1) for the project (S&W Data Logger Memo, Appendix C). The comparison analysis indicated that the Edmonds Marina LTC-1 station was very similar to the Seattle Elliott Bay Station (NOAA Station 9447130) with minor shifts in tidal cycles (on the order of minutes) and elevations (on the order of tenths of a foot). The project therefore used the NOAA Seattle Elliot Bay Station 9447130 tidal data for modeling downstream boundary conditions of tidal water surface elevations for time periods outside the completed project data collection efforts.

A typical spring tidal flow condition was selected from May 2008. This month of May was selected because fish trap and juvenile chinook data indicate peak juvenile migration from the Skagit and Snohomish deltas occurs sometime in mid-April (Beamer pers. comm. with WDFW for Fir Island Farm Estuary Restoration, 2010). We selected early to mid May to account for travel times from the river deltas to the Edmonds area. Stream inflow data were provided by the SAIC stormwater HSPF model outputs. Low flows were selected for Willow and Shellabarger Creeks at (0.3 and 0.5 cubic foot per second) that were selected from other representative low flow modeling periods.

Flood inflows were selected for the December 2007 event, where observations were made at SR 104 and the Unocal stormwater detention pond, both of which were flooded. Edmonds Marsh and Willow Creek overtopped their respective banks onto the Unocal Property during this December 2007 event. All floodwaters were contained onsite, and managed under a construction NPDES permit. The NOAA tide station and HSPF modeling data (SAIC, 2012) were used as inputs for the December 2007 event.

Modeling geometry for the existing conditions used a geographic information system (GIS) surface compiled by Shannon & Wilson from existing LiDAR and ground survey data (Shannon & Wilson GIS Surface Memorandum, Appendix C). Additional bridge survey data were used to model the BNSF bridges based on as-built drawings provided by BNSF to the City. Modeling geometry for the preferred daylight and conceptual design plan used a similar surface that was modified to include the daylight channel along the beach, Unocal property margin, and channel excavations in Edmonds Marsh. Additional details regarding the modeling setup are provided in Appendix B.

5.1.2 Tidal Hydraulics Modeling Results

The tidal hydraulics model was evaluated for existing and preferred daylight – conceptual design alternative conditions for the spring - May 2008 fish migration period, and the flood – December 2007 period. Figures 1 and 9 (main figures) show the predicted inundation areas for the spring tidal inundation periods for existing and proposed conditions. Based on the results of spring migration modeling, the marsh inundated areas will moderately increase from 16.8 to 19.2 acres. This is somewhat limited by the model's ability to assess flow inundation characteristics in the dense thicket of the freshwater cattail areas.

Figures 10 through 17 in Appendix B show the potential changes in channel velocities. Channel velocities in the upper Edmonds Marsh area decrease due to the increased size of the channels from dredging and excavation The proposed peak velocities drop from 1.3 feet per second (fps) (existing) to 0.6 fps (proposed) for Shellabarger Creek. The proposed peak velocities drop from 4.8 fps (existing) to 0.7 fps (proposed) for Willow Creek. . Reductions in stream velocities are a result of elevated backwater conditions caused by the increase in tidal inundation elevations. Reductions in velocities in the low end of the stream channels indicate that the fish will not be required to spend as much energy or effort in navigating the channels. Reductions in velocity also indicate potential increases in sedimentation. Just downstream from the stream channels, in the excavated marsh channels, the model predicts increases in tidal channel velocities. The flow and sediment dynamics along the fringe and transition zone of the marsh, where the streams encounter the high tide, are expected to change with some areas having higher sediment deposition, and others have higher sediment transport conditions.

Immediately downstream from the Willow Creek/Shellabarger Creek confluence, the channel velocities are higher for the proposed condition. They increase from 0.1 fps (existing) to 0.4 – 0.6 fps (proposed). Further downstream in the Willow Creek (Channelized) section of the stream, the velocities increase from 0.2 fps (existing) to 0.6 fps (proposed). In the proposed daylight channel near the railroad bridges, peak velocities can be as high as 1.5 to 2.0 fps (in either flood or ebb direction). Along the beach channel, peak velocities can be 0.5 to 1.0 fps for flood tide, and as high as 5.0 to 6.0 fps for ebb tide.

Figure 19 in Appendix B shows the results of the hydraulic modeling output for the December 2007 flood event. The model predicts significant reductions in peak flood water surface elevations from and estimated 12.7 feet (NAVD88) to an estimated 10.7 feet (NAVD88). This is a significant reduction in flood water surface elevations likely resulting from improved drainage and flow along the daylight channel versus the confinement and losses of the existing stormwater pipe and tidegate.

6.0 FISH HABITAT ASSESSMENT OF THE PREFERRED PLAN

The following information is the analysis of fish habitat conditions that would be provided through the proposed restoration options in the City's Willow Creek Daylighting project. This proposed fish habitat analysis complements the earlier analysis on existing fish habitat conditions that was included in the alternatives analysis. It is expected that this proposed fish habitat analysis will be used as a section of the project team's preliminary feasibility report.

6.1.1 Access to the Marsh

The proposed daylighting of Willow Creek will achieve its primary objective of restoring the connection between Puget Sound and Edmonds Marsh. A surface water connection routed through the City's Marine Park and under the BNSF railroad tracks via a recently constructed bridges will provide water depth and velocity conditions that will enable juvenile salmon, other fish, and other nearshore fauna to enter the marsh system during portions of the tidal cycle. As described below in more detail, the accessibility of the marsh to fish will vary throughout the tidal cycle. There will be times when tidal water will be moving into the marsh which provides the easiest access for fish, and times when access would require fish to swim upstream as the marsh system drains. Overall, access to the marsh will be provided during almost every high tide period with some additional access during limited periods of falling tides immediately after high flood slack.

The restoration design used in the hydrodynamic modeling assumes the thalweg of the proposed entrance channel is +4.26 feet NAVD88 (+6.2 feet MLLW). With this proposed design elevation, it is estimated that water levels in Puget Sound (on an annual basis) will be high enough to inundate at least the lower part of the marsh entrance channel up to 60 percent of the time if no tide gate is used. For incoming flood tides, fish will be able to access the marsh for tide elevations above the inlet elevation.

When the tide is at high slack or a falling tide, the net direction of flow in the entrance channel will reverse outward to Puget Sound. Entrance and accessibility to the marsh will be limited to those times when suitable depths and velocities are available in the entrance and daylight channel. The National Marine Fisheries Service (NMFS, 2011) design criteria for juvenile salmonid upstream passage is a maximum average velocity of 1 fps, calculated based on the 50 percent exceedance flow, and minimum water depth of 0.5 foot.

The modeling results for the May 1 to 15, 2008, period indicate that juvenile salmon access to enter the marsh system will be limited to an approximately 1- to 2-hour period after slack high tide for ebb tide conditions. The tidal hydraulics modeling output data were used to assess juvenile fish passage at three locations along the daylight channel to the marsh and one in the beach area downstream of the BNSF bridges. Depending on the location within the entrance channel, maximum water velocities out of the marsh are predicted to be between 2 and 3 fps. Water velocities in the restored channel across the beach are estimated to range even higher, up to 5.0 to 6.0 feet per second. Fish that enter the channel early in the flood tide cycle would have access to the marsh and daylight channel up to 60 percent of the time. Juvenile fish that access the entrance later in the tidal cycle will have diminished percentage of time in the daylight channel and marsh, depending upon how late they enter compared to the tide reversal.

Based on preliminary hydraulic modeling, it appears that fish entering the marsh during higher tides would have channels and vegetated areas to remain in even during low tide periods. The modeling predicts that tributary base flows (based on average spring flows) will provide residual depths of more than 0.5 feet and 1.5 feet deep in portions of Shellabarger and Willow

Creeks respectively. Fish migrating from Puget Sound into the main marsh area would likely be able to rear in the marsh for longer than a single tidal cycle.

Depending on the restoration design in the beach area, storms may deposit large quantities of sediment and large wood that impacts fish access to the marsh until marsh outflows are sufficient to clear the channel entrance. A design that promotes natural processes of sediment movement and large wood accumulation, while maintaining fish passage is a desirable approach. Engineering of the channel outlet may be needed to protect adjacent infrastructure such as the south parking lot, and the railroad bridge foundations. These natural processes and site infrastructure constraints will be considered further in subsequent phases of design.

6.1.2 Puget Sound Shoreline Function

The proposed daylighting of Willow Creek is expected to improve the rearing conditions along the Puget Sound shoreline for juvenile salmon. By restoring a surface water connection to the marsh, the brackish marsh water and all the prey items and detritus (decaying plant and animal material) will enter the marine nearshore. Currently, all of these inputs enter Puget Sound via a subtidal pipe and may therefore be largely undetected or unavailable to the surface-oriented juvenile salmon rearing and migrating along the shoreline. Regardless of whether the fish enter the marsh system, these inputs can be expected to improve the habitat conditions for juvenile salmon. More prey items will be available in the upper portion of the water column near the shoreline. These prey items will include numerous insects that offer particularly high caloric content and foster rapid fish growth. The brackish water will also provide fish access to lower salinity water to provide a physiological refuge while the juvenile fish continue their acclimation to the marine environment.

6.1.3 Habitat Structure in the Marsh

Habitat conditions for juvenile salmon in the marsh will be improved by the daylighting of the creek and the proposed channel excavation between the creeks and the greater marsh area. The combination of these actions is expected to expand the portion of the marsh that will support salt-tolerant vegetation and improve the connectivity to the Willow and Shellabarger Creek watersheds.

As described in the existing conditions section of this report, the western third of Edmonds Marsh currently supports salt-tolerant vegetation and there is an abrupt transition to a dense thicket of cattails with no discernible surface channel to the creeks. The conceptual restoration design is expected to expand the extent of salt marsh vegetation and accessible habitat for fish, including the creek systems draining into the marsh. The daylighting of the creek to Puget Sound will increase tidal exchange within the marsh to more natural levels, especially if no tide gate is included in the design. The daylighted creek would be expected to allow high tide inundation elevations to match the water surface elevations along the Puget Sound shoreline, thus alleviating the tidal muting issue observed for existing conditions. This increased tidal exchange and restored channel connections in the marsh will promote the expansion of the area of salt-tolerant vegetation species in the marsh.

Salt marshes typically support a wide range of vegetation species with transitions in vegetation community occurring depending on salinity, inundation patterns, and elevation conditions, as well as other environmental parameters. To generally characterize the changes in the vegetation community that can be expected through restoration, anticipated elevations in the marsh were used to estimate the vegetation community that can be supported in different areas in the marsh. General salt marsh vegetation zones based on elevation were applied using vegetation observations in the Snohomish River system (Rice and others, 2012) and other Puget Sound locations[1]. Areas with elevations between the mean tide level and mean high water (MHW) are likely to support low marsh vegetation species, such as Lyngby's sedge (*Carex lyngbyei*), three-square bulrush (*Scirpus americanus*), pickleweed (*Salicornia virginica*), and seashore saltgrass (*Distichlis spicata*). High marsh vegetation will be supported in elevations from MHW to above MHHW. Common high marsh vegetation species include tufted hairgrass (*Deschampsia caespitosa*), Puget Sound gumweed (*Grindelia integrifolia*), Pacific silverweed (*Potentilla anserina*), American beachgrass (*Elymus mollis*), and common cattail (*Typha latifolia*).

Based on the NOAA tidal data for Edmonds (Station #9447427), the project site's approximate range for low marsh vegetation is between 4.4 and 8.0 feet NAVD88 (6.5 and 10.1 feet MLLW). By this approach, the high marsh range is between 8.0 and 8.8 feet NAVD88[2] (10.1 and 10.9 feet MLLW). These elevations are approximate and would likely have ranges of establishment of low and high marsh vegetation. Available elevation data in the marsh indicate that much of the western two-thirds of the marsh area provide elevations suitable to support low marsh vegetation species. Compared to existing conditions, this is a substantial expansion in area. As a result of this anticipated expansion in the low marsh, an equivalent contraction of the

[1] Additional salt marsh vegetation observations were used from the Skagit River estuary (Hood 2009; Shannon & Wilson, 2010), Duwamish (Hummel pers. comm., April 2, 2013), Nisqually (Belleveau 2012), and Commencement Bay (Thom and others, 2000).

[2] Upper end of range approximated as one foot above MHHW.

high marsh can be anticipated. It can also be expected that some of the currently vegetated low marsh areas transition to unvegetated tide flats. Overall, the marsh can be expected to shift from a cattail-dominated system to a more diverse vegetation assemblage.

With these anticipated changes in the vegetation structure in the salt marsh, a shift in prey production can be expected as different insects and invertebrates are associated with different vegetation types and elevations. The availability of these prey types will be substantially increased through both the fish access to the marsh and the outflow of the marsh into the Puget Sound shoreline. However, the amount of prey production would be expected to be similar between existing and proposed conditions (Cordell pers. comm., April 2, 2013).

The restoration design could include the removal of cattails in the central portion of the marsh where the vegetation community is expected to transition from the dense growth of cattails (high marsh) to more of a low-marsh plant assemblage. While this could potentially accelerate the natural transition process that is expected, there is some uncertainty estimating the extent of the transitional area, and caution is advised. It is recommended that cattail removal is either: 1) not included in the initial construction, but instead considered as an adaptive management measure to be implemented if the salt marsh does not develop as expected, or 2) conducted only in a very limited area along the western extent of the cattail area currently.

6.1.4 Access to Willow and Shellabarger Creeks

The conceptual restoration design includes the excavation of channels to provide clear connections between the creeks and the salt marsh. Since there currently are no well-defined channels, this is expected to improve fish access to the creeks. Due to the increase in tidal exchange and flushing of the marsh, there is expected to be sufficient energy for the channels to be sustainable over time. Sedimentation will likely occur at the new tidal – freshwater interface. This depositional zone could fill with sediment over time and limit fish passage at certain flow conditions.

Upstream connectivity to Willow and Shellabarger Creeks is beyond the scope of this early feasibility study. The City and their community partners do have plans, separate from this project, to incrementally improve upstream fish passage and connectivity in the Willow Creek and Shellabarger watersheds.

6.1.5 Contaminant and Pollutant Impacts to Habitat

As described in the existing conditions section, sediment and water quality may be degraded through stormwater and previous industrial operations and adjacent land remediation conditions, and watershed conditions. The quality of fish habitat within the marsh should be considered impaired to some degree by stormwater pollutants and site contamination. The sources and types of pollutants and contaminants are only generally known with little supporting data. Stormwater will continue to introduce pollutants to the marsh system. However, upstream contributing drainages are primarily residential and not industrialized areas and therefore likely have better water quality than industrial and commercial areas. This potential impact to habitat quality was not considered in this current early feasibility study, other than to state that there is a moderate risk that the marsh areas could be impacted by stormwater pollutants and industrial contaminants. Additional stormwater quality, pollutants and contaminates assessments are necessary steps in the next phase of study.

7.0 PRELIMINARY FINDINGS AND RECOMMENDATIONS

Overall, the early feasibility study demonstrates that the Willow Creek daylight preferred restoration plan will improve fish passage to the marsh. A summary of findings and recommendations for the project is as follows:

- The proposed daylighting of Willow Creek will restore the connection between Puget Sound and Edmonds Marsh and provide conditions that will enable juvenile salmon, other fish, and other nearshore fauna to enter the marsh system during portions of the tidal cycle. Generally, access to the marsh will be provided during almost every flood tide above elevation 4.0 feet, and high slack period, with some additional access for fish during short periods of ebb tides.
- The thalweg elevation (selected by the BNSF bridge thalweg elevation) of 4.26 feet would be inundated approximately 60 percent of the time. If juvenile fish enter the channel early in the tidal cycle, they would have access to the marsh up to 60 percent of the time. If fish enter later in the flood tidal cycle, their access will be limited starting 1 to 2 hours after high slack tide due tidal outflow velocities being too high for juvenile fish to navigate.
- The distribution of salt-tolerant vegetation in the marsh will adjust to the restored tidal exchange. It is expected that both unvegetated mud flat and vegetated low marsh areas will expand, while the vegetated high marsh area will diminish in size. As a result, there will be a smaller area of cattails (high-marsh plant) and more of a variety of low-marsh vegetation species. The rates of this transition are unknown.

- Access to the salt marsh will provide juvenile salmon a productive estuarine prey base. The production of insects and other invertebrates can be expected to shift with the changes in vegetation and tidal inundation, but the amount of prey produced may or may not increase with the restoration. There is a moderate risk that sediments within Willow Creek may have sediment and water quality issues, and should be confirmed through data collection in the next phase of study.
- Fish access to Willow and Shellabarger Creeks can be restored.
- The increase in conveyance from the daylight channel does not appear to increase flood water surface elevations as modeled for the December 2007 flood event, and may actually reduce flood water surface elevations.
- Tidal water surface elevations in the marsh are controlled by the tidegate and pipe system. If the tidegate and pipe system are removed, the daylight channel and marsh will see water surface elevations up to the high tide on almost a daily basis. As an example, existing marsh high tide water surface elevations range from 7 to 8 feet in elevation (NAVD88). Proposed conditions would increase daily tidal inundation elevations up to 9 feet (NAVD88) and higher on a daily basis. Removal of the tidegate and pipe system will also improve drainage in the marsh and less ponding may occur.

The results of the preliminary tidal hydraulics and fish habitat assessment for this project were based on the best available data at the time and targeted to meet the specific needs of the early feasibility study. There are several uncertainties and limitations to the evaluations performed for this study. The following recommendations are provided to finalize the feasibility study prior to engaging in final design:

- A tidegate was not analyzed, as the study team wanted to first evaluate system response without a tidegate. The without-tidegate daylight channel analysis preliminary results indicate that flood peak water surface elevations at SR-104 will be reduced, without having a protective tidegate at the downstream end of the system. A tidegate could be installed on the project to limit extreme tides and storm surge flows into the marsh. Evaluation of tidegate alternatives and operating conditions is recommended for future phases of study and design.
- Flow data were provided by a run-off model completed by SAIC (SAIC, 2012); there are no stream flow data available for project area. Some stormwater inflows to the marsh are not currently quantified. Flow data collection is recommended. Additional hydrologic inflow data are needed from the HSPF model and data collection for the WSDOT manhole overflow, Edmonds Point, and Harbor Square stormwater systems.
- Multiple sources of topographic survey data and information, with different spatial resolutions, coverage areas, and collection times, were used to create the digital elevation models used to develop both existing and proposed conditions

hydrodynamic (HEC-RAS) models. There needs to be additional survey in the freshwater vegetation areas of the marsh to confirm ground elevation in dense cattails, and to locate other marsh channel features and reconcile the various sources of survey data. Collect more comprehensive and accurate vegetation and elevation data in the marsh to support more detailed understanding of existing conditions and the potential changes through restoration design.

- The existing conditions model was not calibrated based on synoptic measured flow and water level data in the Marsh, due to lack of data. Calibration and validation of the model is recommended.
- Additional coastal engineering and geomorphologic studies are needed at the beach channel area to account for shoreline littoral drift, wind waves, and storm surges on the beach channel in a park setting.
- Conduct hydrodynamic modeling of multiple scenarios in entrance channel upstream and downstream from BNSF railroad bridges and evaluate the channel invert elevations to assess potential to reduce water velocities and increase the amount of time the marsh would be accessible to juvenile salmon.
- Expanded study of the extent of stormwater pollution, groundwater, and soil contamination that may affect fish habitat is needed.

8.0 LIMITATIONS

This early feasibility study was prepared for the exclusive use of the City, and their representatives for specific application to the Willow Creek Daylight project. Our judgments, conclusions, and interpretations presented in the report should not be construed as a warranty of existing site conditions, nor future estimated conditions.

The data presented in this report are based on limited survey and hydrologic data, and by the early feasibility study phase of the project. Shannon & Wilson is not responsible for conditions or consequences arising from relevant facts that were concealed, withheld, or not fully disclosed at the time the report was prepared. We also note that the facts and conditions referenced in this report may change over time, and that the facts and conditions set forth here are applicable to the facts and conditions as described only at the time of this report. We believe that the conclusions stated here are factual, but no guarantee is made or implied.

This report was prepared for the exclusive use of the City, and its respective representatives, and in no way guarantees that any agency or its staff will reach the same conclusions as Shannon & Wilson, Inc. We have prepared the report within the limitations of scope, schedule, and budget. The conclusions and recommendations presented in this report were prepared in accordance with generally accepted professional geotechnical and environmental engineering principles and practices in this area at the time this report was prepared.

The data presented in this report are based on limited survey and the current phase of early feasibility study development. We believe that the conclusions stated here are factual, but no guarantee is made or implied.

We have prepared Appendix D, “Important Information About Your Environmental Site Assessment/Evaluation Report,” to help you and others in understanding our reports.

SHANNON & WILSON, INC.

David Cline, P.E.
Senior Associate

DRC; KK; PS/drc

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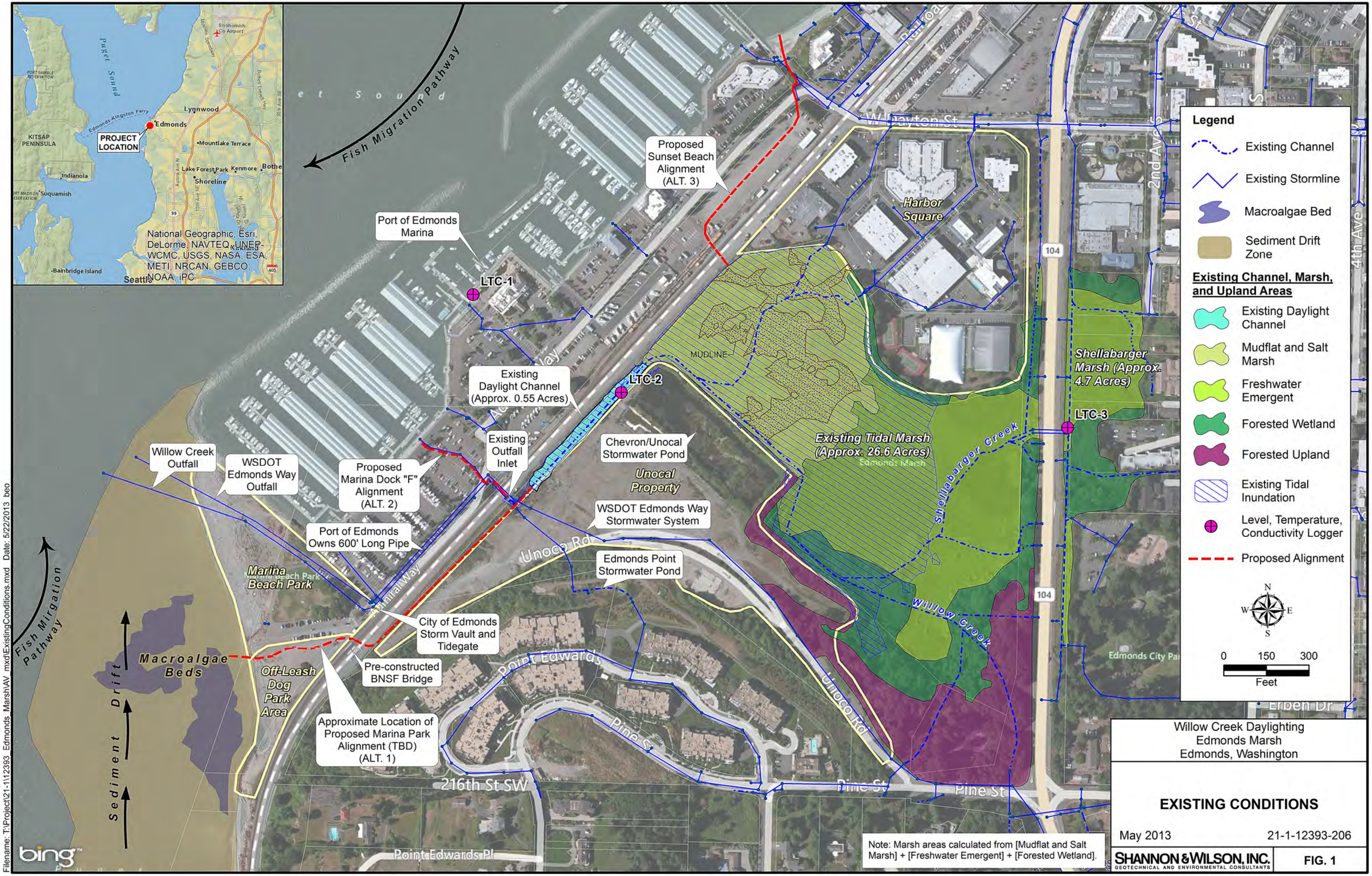
TABLE 1
PRELIMINARY OPINION OF PROBABLE CONSTRUCTION COST
WILLOW CREEK RESTORATION

Item	Description	Quantity	Units	Unit Cost	Item Cost[1]
1.0	Mobilization and Demobilization	1	LS	$ 50,000.00	$ 50,000.00
1.1	Contractor Administration, Submittals, Closeout	1	LS	$ 100,000.00	$ 100,000.00
1.2	Stormwater Erosion Control	1	LS	$ 100,000.00	$ 100,000.00
2.0	Beach Outfall Channel Construction				
2.1	Demolition and Removal (existing tidegate and water main)	1	LS	$ 50,000.00	$ 50,000.00
2.2	Utility Relocations	1	LS	$ 25,000.00	$ 25,000.00
2.3	Dewatering	1	LS	$ 50,000.00	$ 50,000.00
2.4	Channel Excavation	8,000	CY	$ 10.00	$ 80,000.00
2.4.1	Haul and Dispose Excavated Material (uncontaminated)	3,900	CY	$ 10.00	$ 39,000.00
2.4.2	Haul and Dispose Excavated Material (50 percent contaminated)	3,900	CY	$ 95.35	$ 372,000.00
2.5	Erosion Protection Rock (12-inch Riprap)	900	CY	$ 60.00	$ 54,000.00
2.6	Shoring along Parking Area	500	VSF	$ 81.50	$ 41,000.00
2.7	Vegetated Reinforced Soil Wall	500	VSF	$ 81.50	$ 41,000.00
2.7	Pedestrian Bridge				
	Structure Excavation	540	CY	$ 7.00	$ 4,000.00
	Cast-in-Place Concrete	30	CY	$ 300.00	$ 9,000.00
	Pedestrian/Maintenance Bridge	600	SF	$ 200.00	$ 120,000.00
2.8	Self-regulating Tidegate (Option)	1	LS	$ 250,000.00	$ 250,000.00
2.9	Channel and Shoreline Habitat Features	1	LS	$ 50,000.00	$ 50,000.00
2.10	Revegetation	1	LS	$ 25,000.00	$ 25,000.00
3.0	Daylight Channel Construction				
3.1	Channel Excavation	6,800	CY	$ 7.00	$ 47,600.00
3.2	Dewatering	1	LS	$ 100,000.00	$ 100,000.00
3.3	Haul and Dispose Excavated Material (contaminated)	6,800	CY	$ 95.35	$ 648,000.00
3.4	Demolition, Protection, Modification of Stormwater Structures	1	LS	$ 250,000.00	$ 250,000.00
3.5	Channel Liner for Contaminant Protection	45,000	SF	$ 2.50	$ 113,000.00
3.6	Import Clean Liner Backfill	1,700	CY	$ 16.20	$ 28,000.00
3.7a	Railroad Crossing Special Operating Provisions	1	LS	$ 50,000.00	$ 50,000.00
3.7b	Erosion Protection Rock Bedding Material	250	CY	$ 60.00	$ 15,000.00
3.7c	Erosion Protection Rock (12-inch Riprap)	500	CY	$ 60.00	$ 30,000.00
3.8	Revegetation	1	LS	$ 25,000.00	$ 25,000.00
4.0	Marsh Improvements				
4.1	Clearing and Grubbing (remove cattails)	1.4	AC	$ 3,500.00	$ 5,000.00
4.2	Channel Excavation/Dredging	970	CY	$ 50.00	$ 49,000.00
4.3	Haul and Dispose Excavated Material (uncontaminated)	485	CY	$ 10.00	$ 5,000.00
4.4	Haul and Dispose Excavated Material (contaminated)	485	CY	$ 95.35	$ 46,000.00
4.5	Marsh Habitat Features	1	LS	$ 25,000.00	$ 25,000.00
4.6	Revegetation	1	LS	$ 25,000.00	$ 25,000.00
				Equipment, Labor, and Material Costs	$ 2,922,000.00
				Taxes (9.5%)	$ 278,000.00
				Bonding & Insurance (5%)	$ 146,000.00
				Contingency (30%)	$ 1,004,000.00
				Construction Cost	**$ 4,350,000.00**
				Real Estate (TBD)	$ -
				Feasibility, Engineering, Permits (25%)	$ 1,088,000.00
				Project Costs	**$ 5,438,000.00**

1 - Costs are rounded to nearest thousand.



Willow Creek Daylighting
Edmonds Marsh
Edmonds, Washington

EXISTING CONDITIONS

May 2013 21-1-12393-206

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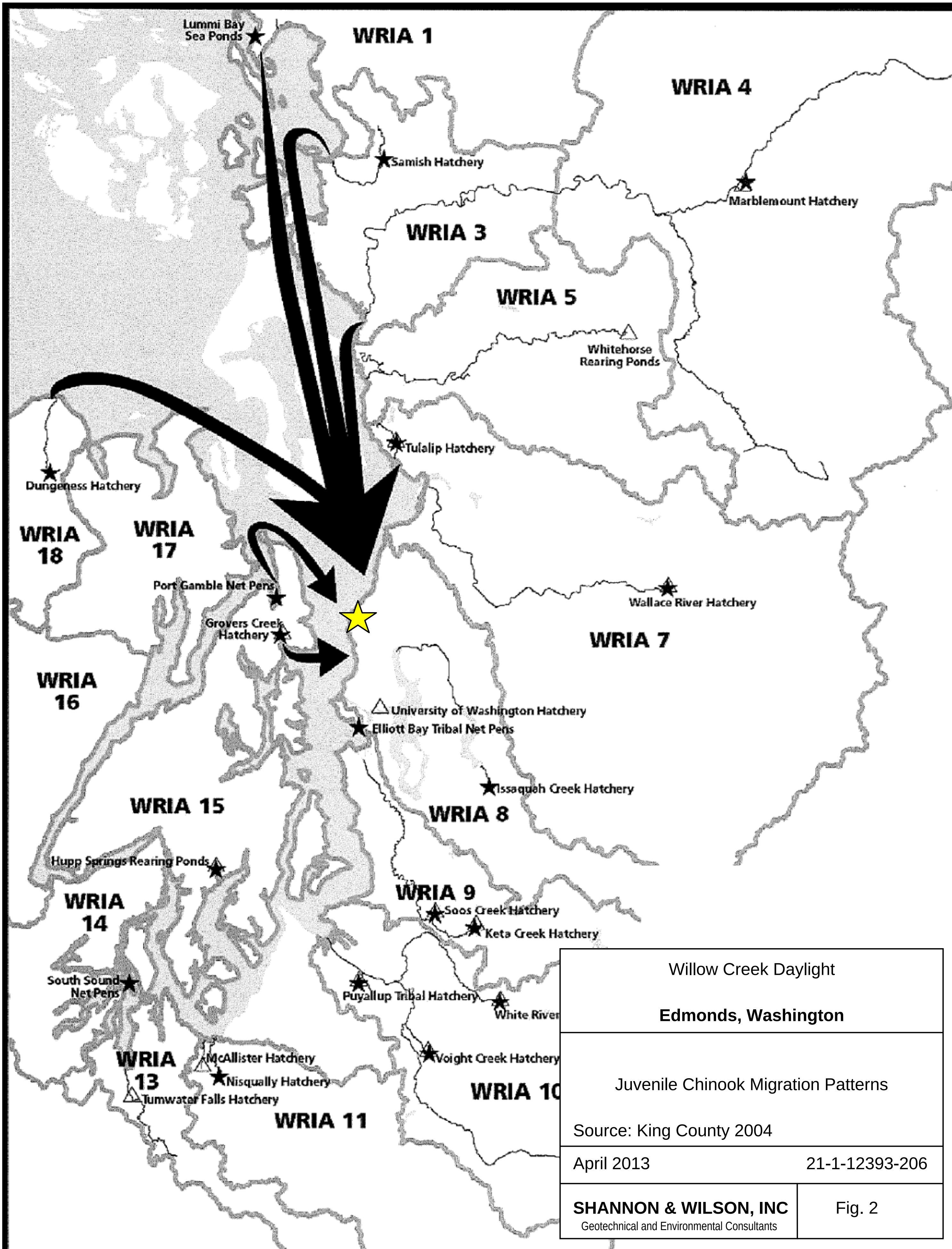
FIG. 1

Filename: T:\Project\21-1\12393_Edmonds MarshAV_mxd\ExistingConditions.mxd Date: 5/22/2013 beo



Willow Creek Daylight

Edmonds, Washington

Juvenile Chinook Migration Patterns

Source: King County 2004

April 2013 — 21-1-12393-206

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Geotechnical and Environmental Consultants

Fig. 2

Willow Creek
Edmonds, WA

1870 HISTORIC MARSH

April 2013 | 21-1-12393-003

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FIG. 3

FIG. 3

FIG 4.

Willow Creek
Edmonds, WA

1944 Edmonds Marsh

October 2012 21-1-12393-003

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FIG 4.

FIG 5.

Willow Creek

Edmonds, WA

1964 Marsh and Unocal Site

October 2012 21-1-12393-003

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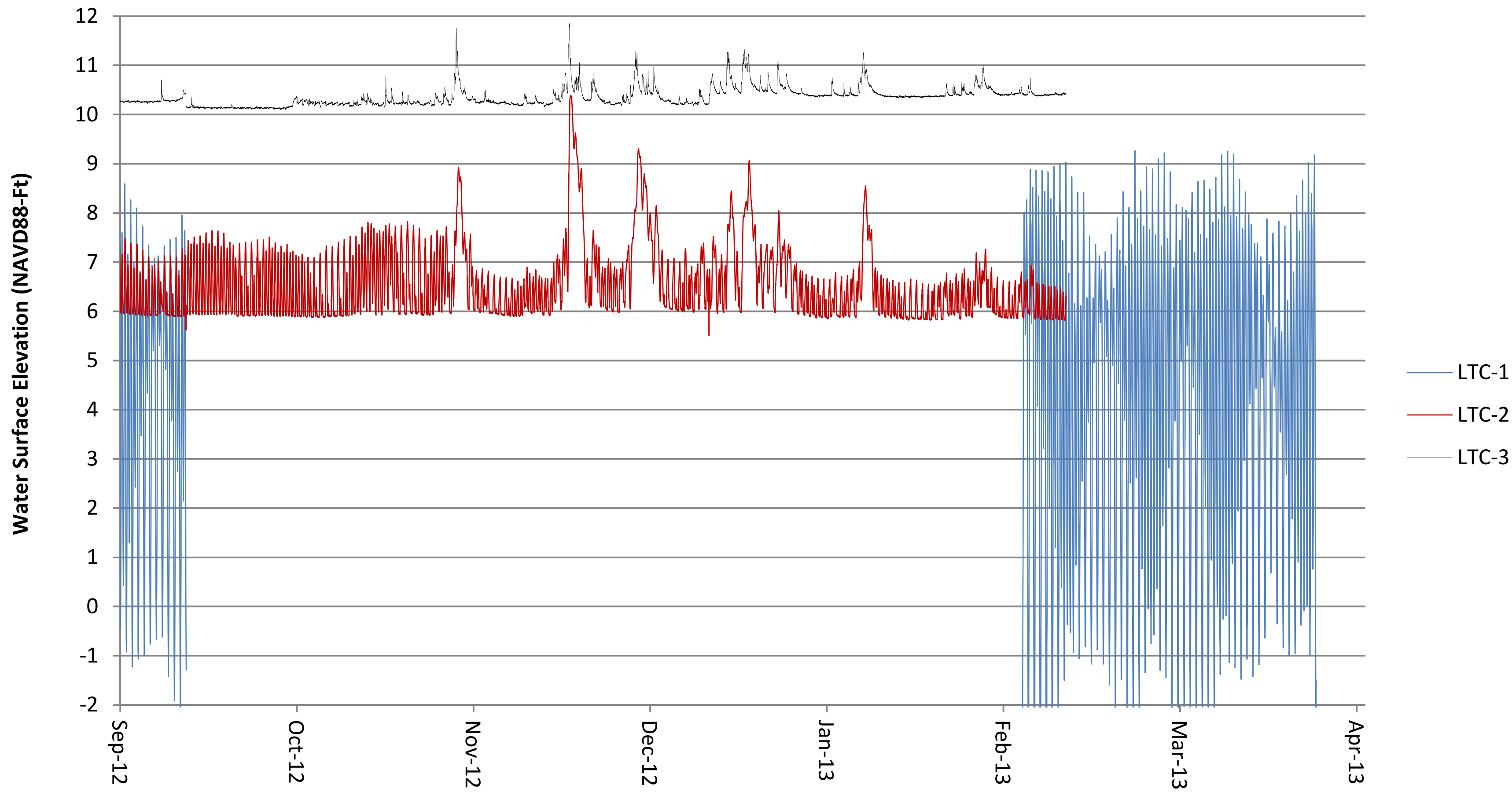
FIG 5.



Note: LTC-1 data logger failed and was replaced February 5, 2013. NOAA Elliott Bay station 9447130 is acceptable replacement for missing data.

Willow Creek

Edmonds, WA

WATER LEVELS
SEPT.2012 - MAR.2013

April 2013 | 21-1-12393-102

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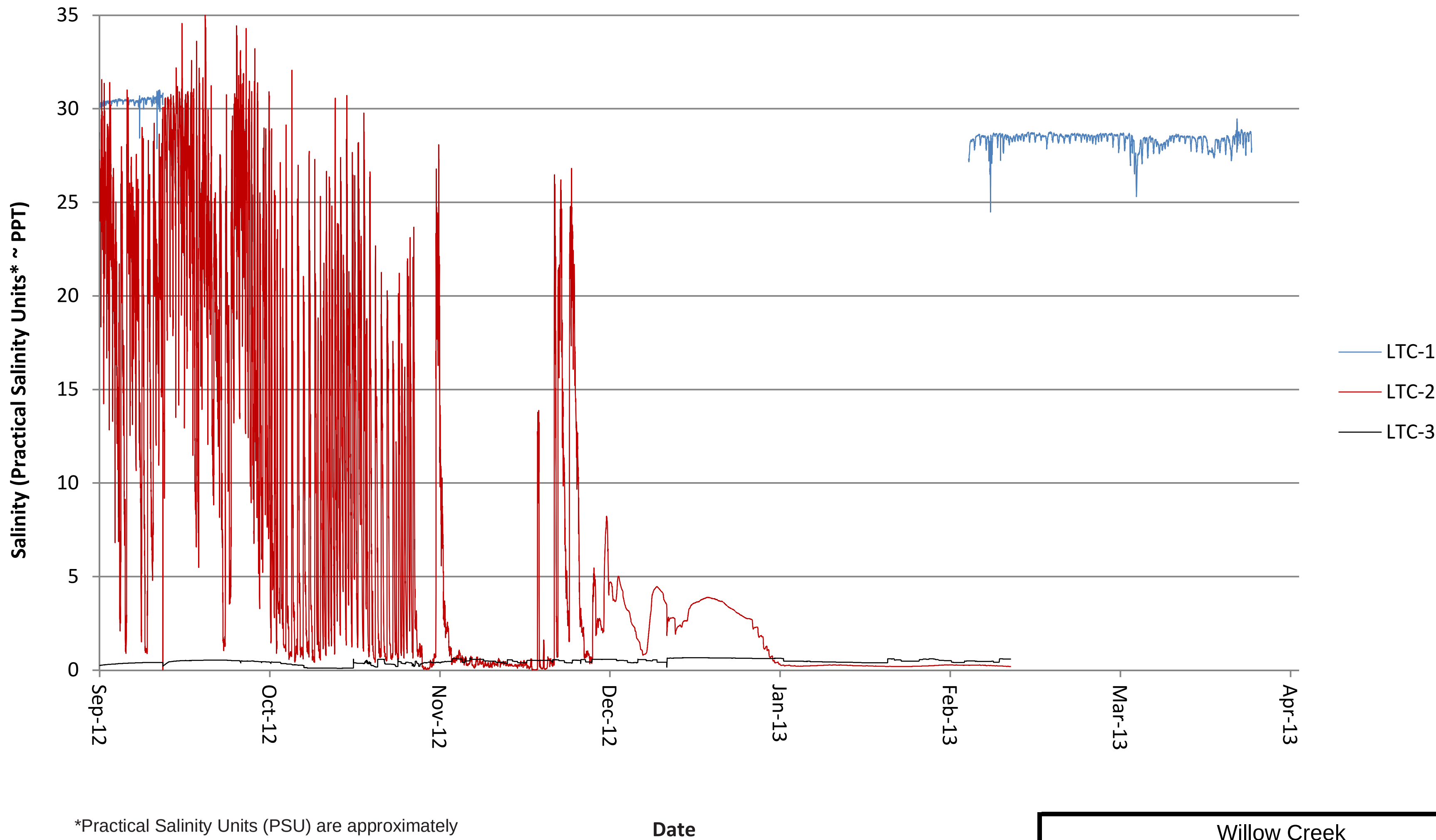
FIG. 6

FIG. 6

I:\WIP\21-1\12393 Willow Creek Daylight\REPORTS\FIGURES\FIGS.6-8_TIDAL_DATA.xlsx <FIG.6_ELEVATIONS>



*Practical Salinity Units (PSU) are approximately equivalent to Parts Per Thousand (ppt)

Note: LTC-1 data logger failed and was replaced February 5, 2013. NOAA Elliott Bay station 9447130 is acceptable replacement for missing data.

Willow Creek
Edmonds, WA

SALINITY
SEPT.2012 - MAR.2013

April 2013 | 21-1-12393-102

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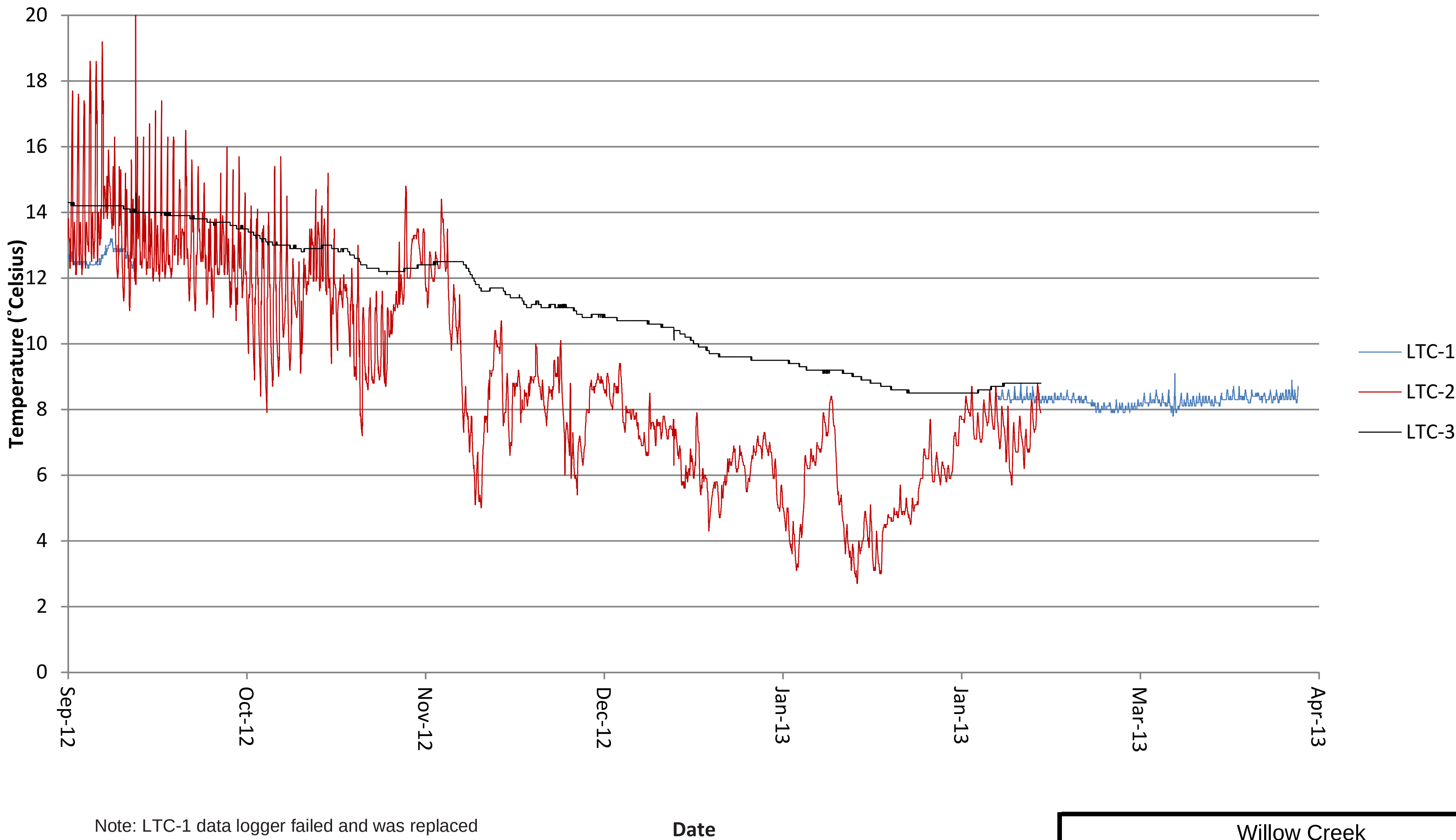
FIG. 7

FIG. 7

I:\WIP\21-1\12393 Willow Creek Daylight\REPORTS\FIGURES\FIGS.6-8_TIDAL_DATA.xlsx <FIG.7_SALINITY>



Note: LTC-1 data logger failed and was replaced February 5, 2013. NOAA Elliott Bay station 9447130 is acceptable replacement for missing data.

FIG. 8

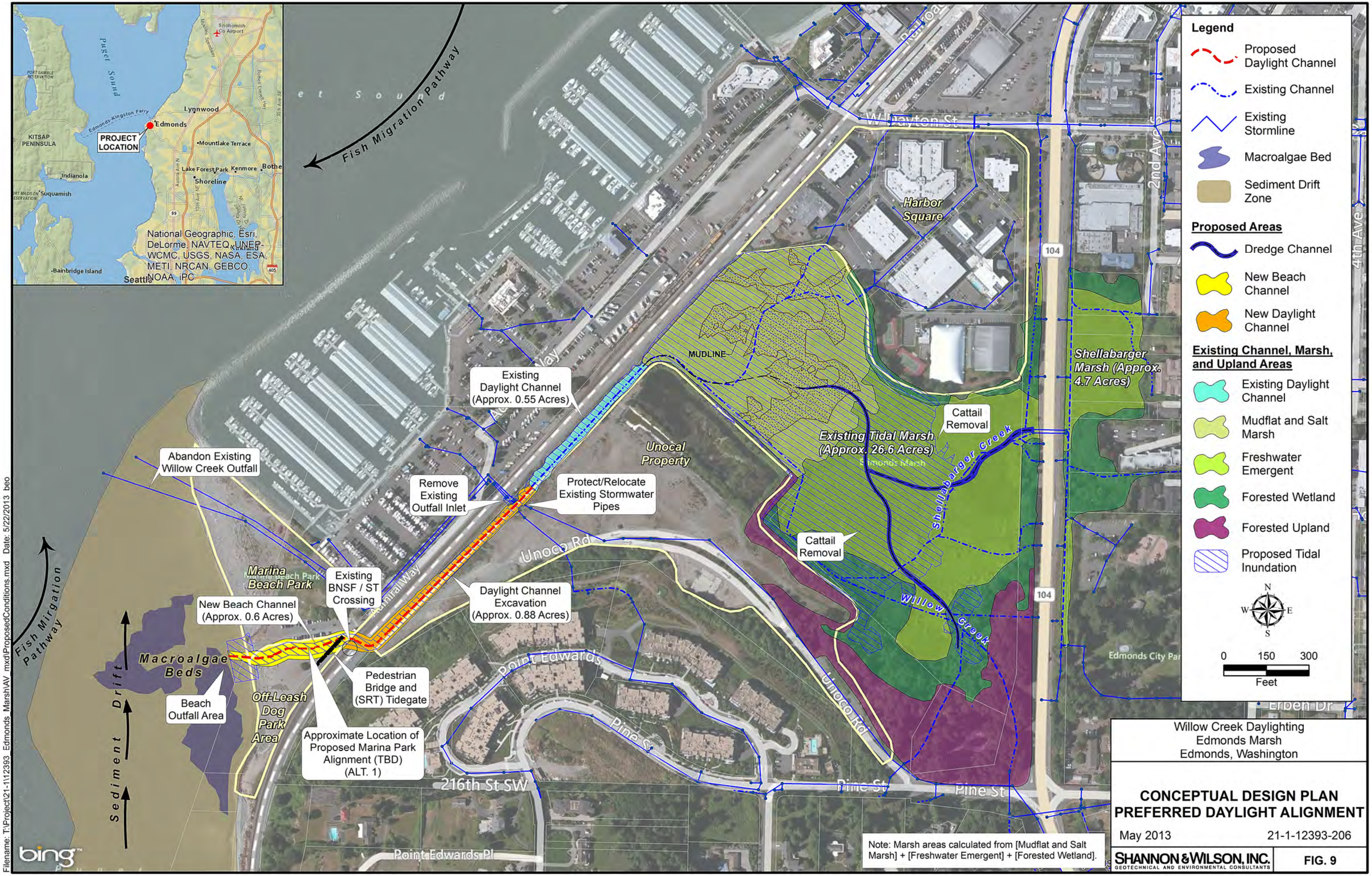
Willow Creek
Edmonds, WA

TEMPERATURE
SEPT.2012 - MAR.2013

April 2013 | 21-1-12393-102

SHANNON & WILSON, INC. GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

FIG. 8



Filename: T:\Project\21-1\12393_Edmonds_Marsh\AV_mxd\ProposedConditions.mxd Date: 5/22/2013 beo

APPENDIX A

PHOTOGRAPHS

APPENDIX A

PHOTOGRAPHS

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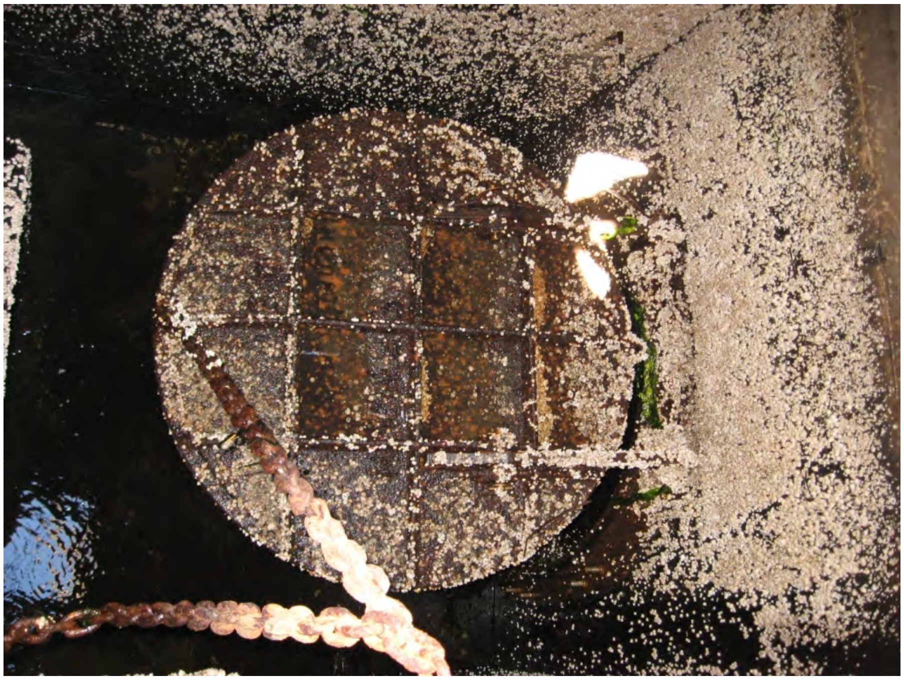
Photograph 8 – Looking at low marsh vegetation Edmonds Marsh.

Photograph 9 – Looking upstream at Willow Creek crossing underneath BNSF Railway.

Photograph 10 – Looking downstream Willow Creek outlet to vault underneath Admiral with 48-inch concrete pipe.



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Photograph 15 – Marina Beach dog park area.

Photograph 16 – Marina Beach south parking lot.

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Photograph 16 – Marina Beach south parking lot.

Photograph 17 – Marina Beach north parking lot and grassy knoll.

Photograph 18 – Marina dock pier LTC-1 gage near Docks “F” and “G”.

APPENDIX B

TIDAL HYDRAULICS REPORT

FINAL TIDAL MARSH HYDRODYNAMICS REPORT

WILLOW CREEK DAYLIGHT EARLY FEASIBILITY STUDY

Prepared for

Shannon and Wilson, Inc.

400 North 34th Street, Suite 100

Seattle, Washington 98103

Prepared by

Anchor QEA, LLC

720 Olive Way, Suite 100

Seattle, Washington 98101

May 2013

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LIST OF ACRONYMS AND ABBREVIATIONS

City	City of Edmonds
Confluence	Confluence Environmental
ft/s	feet per second
HEC-RAS	Hydrologic Engineering Center River Analysis System
LiDAR	Light Detection and Ranging
Marsh	Edmonds Marsh
MLLW	mean lower low water
NAVD 88	North American Vertical Datum of 1988
NOAA	National Oceanic and Atmospheric Administration
NOS	National Ocean Service
psu	practical salinity unit
S&W	Shannon and Wilson, Inc.
SR	State Route
WSDOT	Washington State Department of Transportation

1 INTRODUCTION

Anchor QEA, LLC, was retained by Shannon and Wilson, Inc. (S&W) to complete a preliminary evaluation of existing tidal hydrodynamics within Edmonds Marsh (Marsh), as well as predicted future tidal hydrodynamics in the Marsh based on a proposed new entrance channel to the project site (preferred alternative). This work was completed to support the Willow Creek Daylight Early Feasibility Study being conducted by S&W, Confluence Environmental (Confluence), and Anchor QEA for the City of Edmonds (City) (S&W 2012).

2 PURPOSE OF HYDRODYNAMIC EVALUATION

The purpose of the early feasibility hydrodynamic evaluation was to evaluate, assess, and compare tidal hydrodynamics in the Marsh for existing and proposed conditions (preferred alternative for new entrance channel) for typical spring fish migration flow and approximate 100-year flow conditions in the basin. The results of this study were used to assess the potential to maintain a permanent connection between the Marsh and Puget Sound, inform an evaluation of potential fish passage and use of the restored Marsh and evaluate potential for upland flood impacts due to construction of the new entrance channel.

3 SITE DESCRIPTION

Edmonds Marsh is an approximate 27-acre estuarine marsh located within the City of Edmonds (Figure 1). It is bordered by State Route 104 to the east; Harbor Square to the north; the BNSF Railroad tracks to the west; and the Unocal property (and 216th Street SW) to the south. The Marsh is tidally influenced by Puget Sound; the current connection between the Sound and the Marsh is a complex system of pipes, culverts, gates, and storage ponds (SAIC 2012; S&W 2012). The Marsh also receives freshwater runoff from approximately 900 acres, including two creeks and run-off from surrounding properties (Sea-Run Consulting 2007). Elevations within the Marsh (based on the digital elevation model developed by S&W; see Table 2) range from approximately 4 feet North American Vertical Datum of 1988 (NAVD 88) (6.2 feet mean lower low water [MLLW]) to 13 feet NAVD 88 (15.2 feet MLLW). Detailed information regarding existing and historical site conditions of the Marsh can be found in the *Alignment Alternatives Screening Analysis Report* (S&W 2012).

4 EVALUATION OF TIDAL HYDRODYNAMICS

Existing and future tidal hydrodynamics (post-restoration) within the Marsh were evaluated using a combination of site specific data collection and numerical modeling. Data collection included targeted site survey (conducted by Perteet in June 2012) and water level loggers installed in the Marsh and in Puget Sound within the Port of Edmonds Marina (by Shannon and Wilson from September 2012 to present). These data were used to evaluate tidal attenuation through the current connection of the marsh with Puget Sound (tide gage system) and the corresponding tidal inundation of the Marsh.

Modeling efforts included development of a one–dimensional hydraulic model for both existing and proposed conditions (preferred new channel alternative). The models were used to evaluate tidal inundation, water depths, and in-channel velocities in the Marsh for both existing and future proposed conditions based on typical low flow and approximate 100-year flood flow conditions. The model used for the evaluation was HEC-RAS, a one-dimensional hydraulic model developed by the U.S. Army Corps of Engineers Hydrologic Engineering Center River Analysis System (HEC-RAS).

4.1 Tidal Information and Water Level Data

Tidal elevations for the project site were taken from the National Oceanic and Atmospheric Administration (NOAA) National Ocean Service (NOS) tidal benchmark in Elliott Bay, Seattle, Washington (gage #9447130). Tidal heights at Elliott Bay were compared to water level data measured in Port of Edmonds Marina (see Appendix A) for the same time period, and the data were found to be in phase and have the same magnitude (within a few tenths of a foot). Therefore, tidal data at Elliott Bay was determined to be representative of tidal heights in the Sound at the project location. Conversion between MLLW and NAVD 88 was taken from NOAA's VDATUM software. This information is provided in Table 1.

Table 1
Tidal Elevations at the Project Site (based on NOAA Gage #9447130)

Tidal Elevation (feet)	Based on MLLW Datum (feet)	Based on NAVD 88 Datum (feet)
Mean higher high water	11.2	9.3
Mean high water	10.3	8.4
Mean tide level	6.5	4.4
Mean low water	2.7	0.6
NAVD 88 (feet)	2.1	0.0
Mean lower low water	0.0	-2.1

Notes:
NAVD 88 = North American Vertical Datum of 1988
MLLW = mean lower low water

Extreme high tide at the project site is approximately 12 feet NAVD 88 (14 feet MLLW), but occurs only a few times per year based on hourly water level data at Elliott Bay (Appendix A).

Water level data was collected synoptically in the Marsh, above SR 104 in Shellabarger Creek and in Puget Sound (Port of Edmonds Marina) from September 2012 through the present. The loggers measured water level, salinity, and temperature over the deployment time period.

A map showing the locations of the data loggers and water level, salinity, and temperature data from September 1 to September 14, 2012, is provided in Appendix A.

- Water surface elevations in the Marsh (Location LTC-2) oscillate between 6 feet NAVD 88 (8.2 feet MLLW) and approximately 7.5 feet NAVD 88 (9.7 feet MLLW).
- The highest water level in the Marsh (over the tidal cycle) lags behind the high tide elevation in Puget Sound (Location LTC-1). Also, water surface elevations in the Marsh drop more slowly than those in Puget Sound. This is typical of systems where the tidal incursion is limited by control structures (i.e., culverts, tide gates, weirs, etc.).
- Water levels in Shellabarger Creek remain relatively constant over the tidal cycle (at just higher than 10 feet NAVD 88 [12.2 feet MLLW]).

- Salinity in Shellabarger Creek is quite low (less than 1 practical salinity unit [psu]) and remains relatively constant over the tidal cycle.
- Salinity in the marsh tends to oscillate between 30 psu (the salinity measured in Puget Sound) and approximately 15 psu (see Appendix A, Figure 3). However, there are times when the salinity drops significantly to below 5 psu due to freshwater inflows from Shellabarger or Willow creeks or other upland stormwater flows that drain into the Marsh. Salinities in the creek are also reduced when the tide gate is closed, which limits salt water intrusion into the creek.
- Temperature in the Marsh (over the period of record shown in Appendix A) appears to be relatively constant in Puget Sound and in Shellabarger Creek, but oscillates between 12 degrees Celsius and 18 degrees Celsius.
  - The increase with temperature on incoming tide (above the water temperature in Puget Sound) is not unusual. However, it may be due to water that was previously held downstream within stormwater pipes and storage ponds now being transported upstream into the Marsh during incoming tide. The water temperatures in the Marsh decrease after September 9 or 10, which may be a result of a higher flow event in Shellabarger Creek during that time.

4.2 Existing Conditions HEC-RAS Model

An existing conditions HEC-RAS model of the project area was developed using topography, water level, and flow data from several sources, as listed in Table 2.

Table 2

Data Sources Utilized in Existing Conditions HEC-RAS Model

Date Type	Source	Spatial Extent	Temporal Extent
Topography/Stream Geometry	Shannon & Wilson; Digital Terrain Model	Project Area	N/A
Culvert Geometry	Shannon & Wilson; Survey Data	Project Area	N/A
Spring Tidal Data	NOAA	Lower Willow Creek	May 1-15, 2008
High Flow Tidal Data	NOAA	Lower Willow Creek	Dec 17-31, 2007

Date Type	Source	Spatial Extent	Temporal Extent
Spring Flow Conditions	Provided by Shannon & Wilson; taken from SR-104 HSPF Model (SAIC 2012)	Shellabarger Creek & Upper Willow Creek	May 1-15, 2008
High Flow Conditions	Provided by Shannon & Wilson; taken from SR-104 HSPF Model (SAIC 2012)	Shellabarger Creek & Willow Creek	Dec 1-14, 2007
Predicted Water Surface Elevation Data in the Marsh (High Flows)	Provided by Shannon & Wilson; taken from SR-104 HSPF Model (SAIC, 2012)	Willow Creek (at Section 1285 as shown in Figure 2)	Dec 1-14, 2007

Note:
NOAA = National Oceanic and Atmospheric Administration

Surface data from S&W were processed using HEC-GeoRAS, a tool developed for ArcGIS to process geospatial data for use in the HEC-RAS model. HEC-RAS geometry data were developed from HEC-GeoRAS at cross-sections within the project area. The cross-sections and existing surface data are shown in Figure 2.

Cross-sections were adjusted and culverts were added as necessary using survey data provided by S&W. Manning's roughness coefficients were estimated using professional judgment and available literature.

The HEC-RAS model was run as an unsteady flow model to simulate tidal cycles during a typical spring period (see Figure 4) and a typical low-flow and high-flow event. Low flows were provided by SAIC and represent average flows during May in Shellabarger and Upper Willow creeks (0.5 cfs and 0.3 cfs, respectively). The high-flow event was provided by flood modeling work completed by SAIC and represents a flow event in December 2007 (see Figure 5). To improve the stability of the model, the model was split into three reaches (Upper Willow Creek, Shellabarger Creek, and Lower Willow Creek). To further improve stability, the downstream boundary location was set at the storm vault entrance upstream of the tide gate. Downstream boundary conditions for Lower Willow Creek were set to the higher of the bottom of the storm vault entrance or NOAA tidal data (spring)/SAIC water surface elevations (high flow). Downstream boundary conditions for Upper Willow Creek and Shellabarger Creek were set to the water surface elevation at the uppermost cross-section of Lower Willow Creek. Flow conditions were assumed to be concurrent such that the Lower Willow Creek flow was equal to the sum of the Upper Willow Creek and Shellabarger Creek flows. Simulation time periods were set for 2 weeks.

4.3 Proposed Conditions Model

The proposed conditions model was developed based on the existing conditions model and geometry for the preferred alternative for the proposed new channel developed by S&W (S&W 2012). Data sources used to develop the proposed conditions model are the same as those provided in Table 2. However, a new digital terrain model was provided by S&W that included the preferred alternative design for the new entrance channel in the topography. The thalweg of the new entrance channel just above the railroad bride is similar in elevation to the existing downstream thalweg in Willow Creek —approximately 4 feet NAVD 88 (6.2 feet MLLW).

Cross-section locations were kept the same as the existing model, where possible. In new channel areas, cross-sections were moved to capture likely flow paths. Figure 3 shows the proposed model cross-section locations and proposed surface. The downstream boundary location for Lower Willow Creek in the proposed conditions is at the channel outlet to Puget Sound. All other conditions remained the same as those described in the existing conditions model.

4.4 Model Results

Four model simulations were completed: one low-flow and one high-flow simulation for both existing and proposed conditions. Each simulation was run for a 2-week timeframe with a tidal downstream boundary condition (see Figure 4). Results for the low- and high-flow simulations are described in detail below.

4.4.1 Low-flow Model Runs

The purpose of the low-flow model runs was to evaluate tidal inundation based on existing and proposed conditions and to provide predictions of in-channel flow velocities in the Marsh to assess fish access.

Figures 6, 7, and 8 show predicted inundation areas for existing and proposed condition, and a comparison of these inundation areas, based on results of the low-flow HEC-RAS model runs. Figures 10 to 17 provide average in-channel velocities for existing and proposed conditions at various locations (see Figure 9) within the project area as predicted by the HEC-RAS model. Following is a summary of model results for the low-flow HEC-RAS simulations:

- Predicted Inundation at low flows is not *significantly* different between existing and proposed conditions (16.8 acres compared to 19.2 acres, respectively). However, the proposed conditions do show a slightly larger inundation area (based on available topography and hydrodynamic conditions modeled).
- Predicted Maximum velocities in Willow Creek in the salt marsh area would increase because of proposed conditions from 0.2 feet per second (ft/s) to 0.6 ft/s, because of an increase in the tidal prism once the new channel is constructed (Figure 13).
- Predicted Maximum velocities in Willow Creek in the channelized section parallel to the railroad would increase because of proposed conditions from 1 ft/s to 3 ft/s (Figure 14).
- Predicted Maximum velocities in the proposed new outlet channel would be 1.8 ft/s upstream of the railroad bridge and could get as high as 5 ft/s in the channel outlet on the beach (at low tide) (Figures 15, 16, and 17).
- Predicted velocities in Shellabarger Creek and Upper Willow Creek are higher for existing conditions than for proposed conditions (Figures 10 and 11). This is due to an increase in channel cross-section in this area due to excavation proposed as part of the preferred alternative.

4.4.2 High-flow Model Runs

Figures 18 and 19 provide flow and velocity information, respectively, predicted by the HEC-RAS model for existing and proposed conditions in the Marsh. A summary of model results for the high flow HEC-RAS simulations is provided below:

- Low tide water surface elevations just upstream of the railroad bridge (in the proposed new channel) are increased during the flood event, but high tide water surface elevations are not noticeably higher than normal high tide conditions during the flood event.

- Water surface elevations just downstream of the confluence of Shellabarger and Willow creeks increase to just below 13 feet NAVD 88 (15.2 feet MLLW) for existing conditions. This elevation compares well with the reported 100-year flood elevation for the Marsh provided in SAIC 2012.
- Water surface elevations just downstream of the confluence of Shellabarger and Willow creeks for proposed conditions do not get above 11 feet NAVD 88 (13.2 feet MLLW) during the flood event.

5 PRELIMINARY CONCLUSIONS AND NEXT STEPS

Based on the review of site-specific data (Section 4.1) and results of the modeling effort (Section 4.2), several preliminary conclusions can be made regarding the performance of the preferred alternative (new channel) compared to existing conditions in the Marsh:

- The increase in conveyance in the channel due to proposed conditions does not appear to significantly increase water surface elevations in the Marsh during the approximate 100-year flood event (compared to published flood elevations in the marsh for existing conditions). It may decrease water surface elevations in Willow Creek and the Marsh (when tide gate is open) due to increased conveyance in the system post-project.
- The thalweg of the proposed new entrance channel (approximately 4 feet NAVD 88, 6.2 feet MLLW) will control the low tide elevation of water in the Marsh at low tide; it will equal the thalweg elevation. It will also control the frequency of tidal inundation into the Marsh, and the grade and velocity of flow in the beach channel during lower tides for proposed conditions. Based on tidal elevations in Puget Sound at Elliot Bay (Appendix A), tides are higher than 6.2 feet MLLW approximately 60% of the time on an annual basis.
- Water surface elevations in the Marsh are currently controlled by the existing tide gate system and are lower than high tide elevations in Puget Sound during the portions of the year that the existing tide gate is closed (October through March). If the gate is removed (and not replaced), the Marsh site and adjacent streams will see water surface elevations up to mean high tide elevations (9.3 feet NAVD 88) on an almost daily basis. The area could also see water surface elevations up to highest high tide elevations (astronomical), approximately 12 feet NAVD 88) a few times throughout the year. At the low flows modeled as part of this study, these increased tidal elevations in the Marsh area will likely not impact water surface elevations in the upstream culvert at SR-104 (13.4 feet NAVD88).
- Salinity intrusion in the Marsh system based on proposed conditions was not modeled explicitly. However, some general thoughts on salinity post-project in the Marsh area have been developed based on evaluation of salinity data collected as part of this work by S&W (see Appendix A, Figure 3).

  - Maximum salinity in the Marsh area at low flows (when the tide gate is open) at higher tides is currently at Puget Sound levels. Therefore, increased conveyance should not increase the maximum salinity in the Marsh, but may decrease the salinity range (by increasing salinity at lower tides).
  - Elevations within the Marsh area at the upper end of the tidal range (9 to 12 feet NAVD 88) may see some increase in average and maximum salinities at low flows due to increased conveyance of the proposed new channel outlet.
  - During high-flow events, portions of Willow Creek and the Marsh area upstream of the new opening may experience lower salinities (compared to existing conditions) due to increased conveyance of the proposed new channel outlet.

- A tide gate could be installed on the outflow channel to the Marsh (at the bridge) to limit water surface elevations in the Marsh, as is done currently. However, this will also limit conveyance through the bridge opening and the amount of time that fish will be able to enter or exit the marsh. Since fish access to the marsh is a primary goal of the project, a separate alternatives analysis of with and without tide gate is recommended for the feasibility phase of study.
- There needs to be additional hydraulic study to quantify other stormwater flows into the Marsh that are not captured in the current run-off model. These sources include the Washington State Department of Transportation (WSDOT) Edmonds Way manhole overflow, Edmonds Point stormwater system, and any additional back flooding from the Dayton stormwater system.
- There needs to be additional survey in the Marsh to increase data coverage (in areas where Light Detection and Ranging (LiDAR) could be impacted by vegetation) and decrease uncertainty in the inundation maps developed as part of this phase of work.
- There needs to be additional alternatives analysis and subsequent design refinement to the outflow channel on the beach to account for impacts of wind-waves, littoral drift (in-filling), and planned park and public uses.

6 UNCERTAINTY DISCUSSION

The results of the preliminary tidal hydrodynamic evaluation for this project were based on the best available data at the time and targeted to meet the specific needs of the early feasibility evaluation. Uncertainties in the model are due to limitations of the input data to the model (i.e., topography, flows, and water levels) and assumptions made by the model itself. Specific potential sources of uncertainty with this study include:

- Multiple sources of topography information, with different spatial resolutions, coverage areas, and collection times, were used to create the digital elevation models used to develop both existing and proposed conditions hydrodynamic (HEC-RAS) models.
- Flow data was provided by a run-off model completed by SAIC (SAIC, 2012); there are no stream gage data available for project area.
- The existing conditions model was not calibrated based on concurrent measured flow and water level data in the Marsh, due to lack of data.
- Some stormwater inflows to the marsh are not currently quantified.

7 REFERENCES

SAIC, 2012. *Dayton Street and SR 104 Storm Drainage Alternatives Study (DRAFT).* Prepared for the City of Edmonds. November 2012.

Sea-Run Consulting, TetraTech, Inc., Reid Middleton, Inc., and Pentec, 2007. *City of Edmonds; Shoreline Master Program Update; Shoreline Inventory & Characterization*. SMA Grant Agreement No. 60600108. Prepared for City of Edmonds. November 2007.

Shannon and Wilson, Inc., 2012. *Alignment Alternatives Screening Analysis; Willow Creek Daylight Early Feasibility Study*. Prepared for People for Puget Sound. September 2012.

FIGURES

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NOTES:
Base Map: ESRI Data and Maps [DVD]. (2009). Redlands, CA: Environmental Systems Research Institute
Aerial: Bing Maps

ANCHOR QEA

Feet
0 300 600

Figure 1
Site Location Map
Tidal Marsh Hydrodynamics Report (DRAFT)
Willow Creek Daylight Early Feasibility Study

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NOTES:
Existing surface source: Shannon & Wilson
Aerial source: Bing

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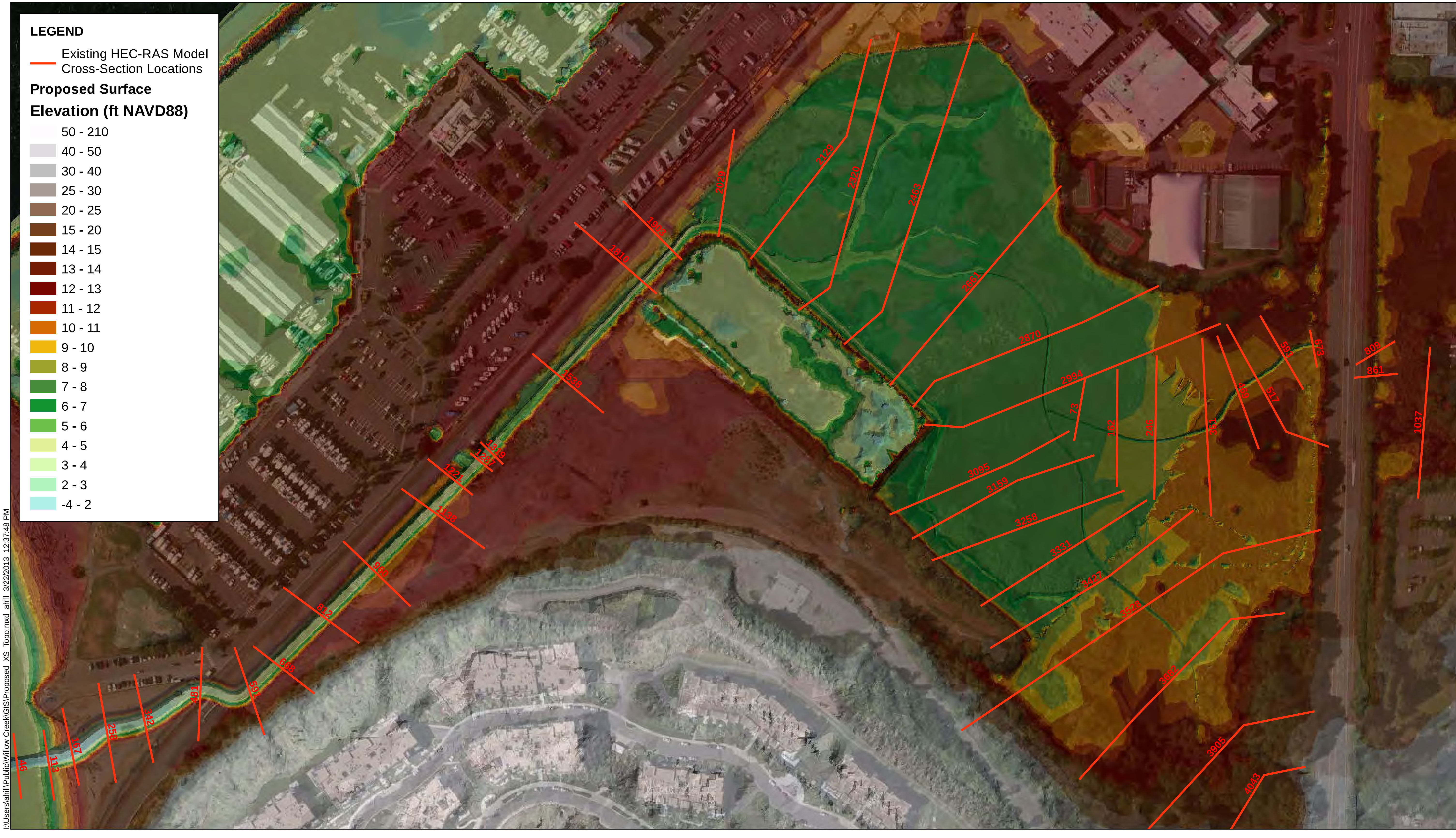
Figure 2
Existing Marsh Topography and HEC-RAS Model Cross-Section Locations
Tidal Marsh Hydrodynamics Report (DRAFT)
Willow Creek Daylight Early Feasibility Study

ANCHOR QEA



NOTES:
Proposed surface source: Shannon & Wilson
Aerial source: Bing

Figure 3
Proposed Marsh Topography and HEC-RAS Model Cross-Section Locations
Tidal Marsh Hydrodynamics Report (DRAFT)
Willow Creek Daylight Early Feasibility Study

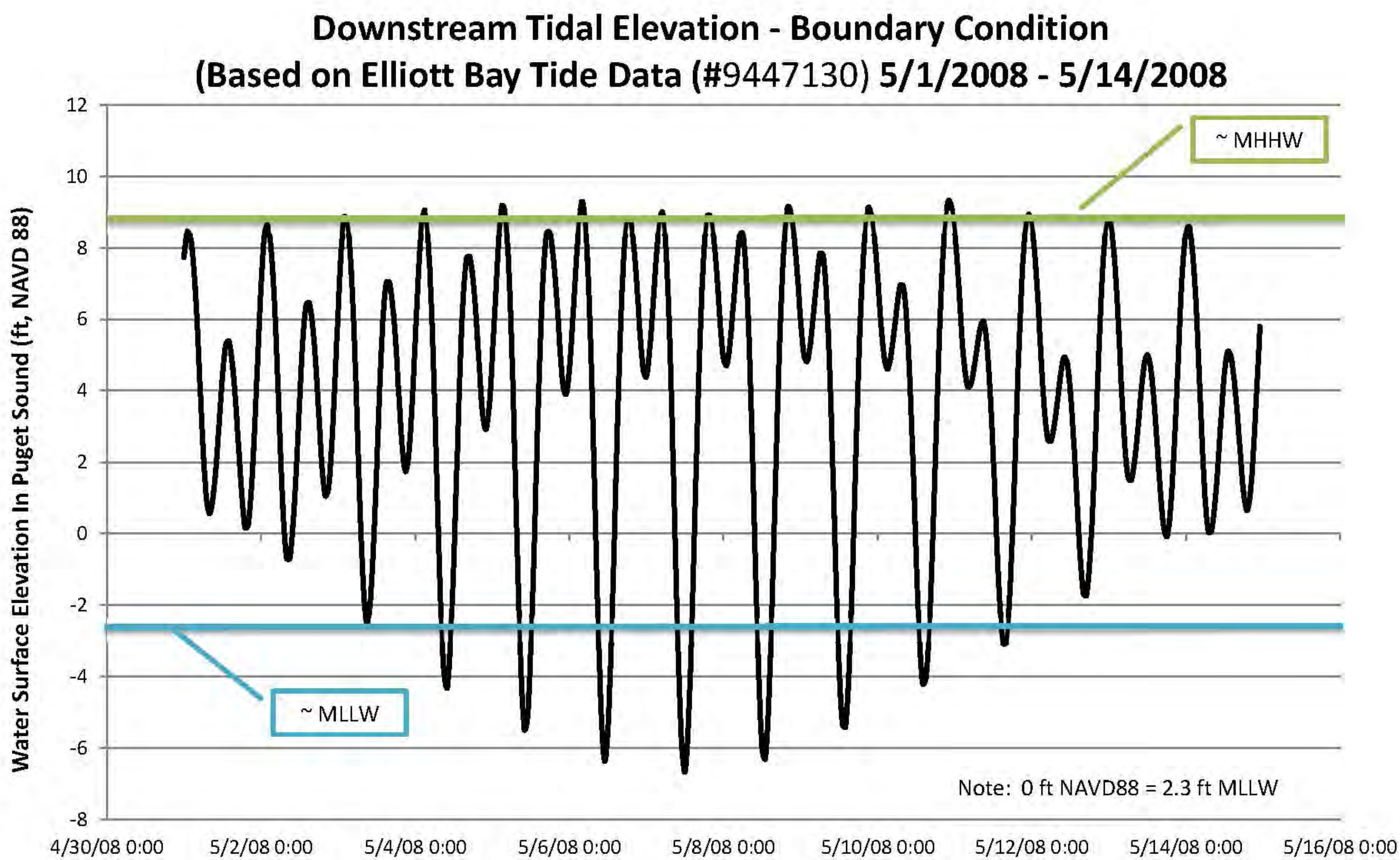


Figure 4
Tidal Boundary Conditions
Tidal Marsh Hydrodynamic Report (DRAFT)
Willow Creek Daylight Early Feasibility Study

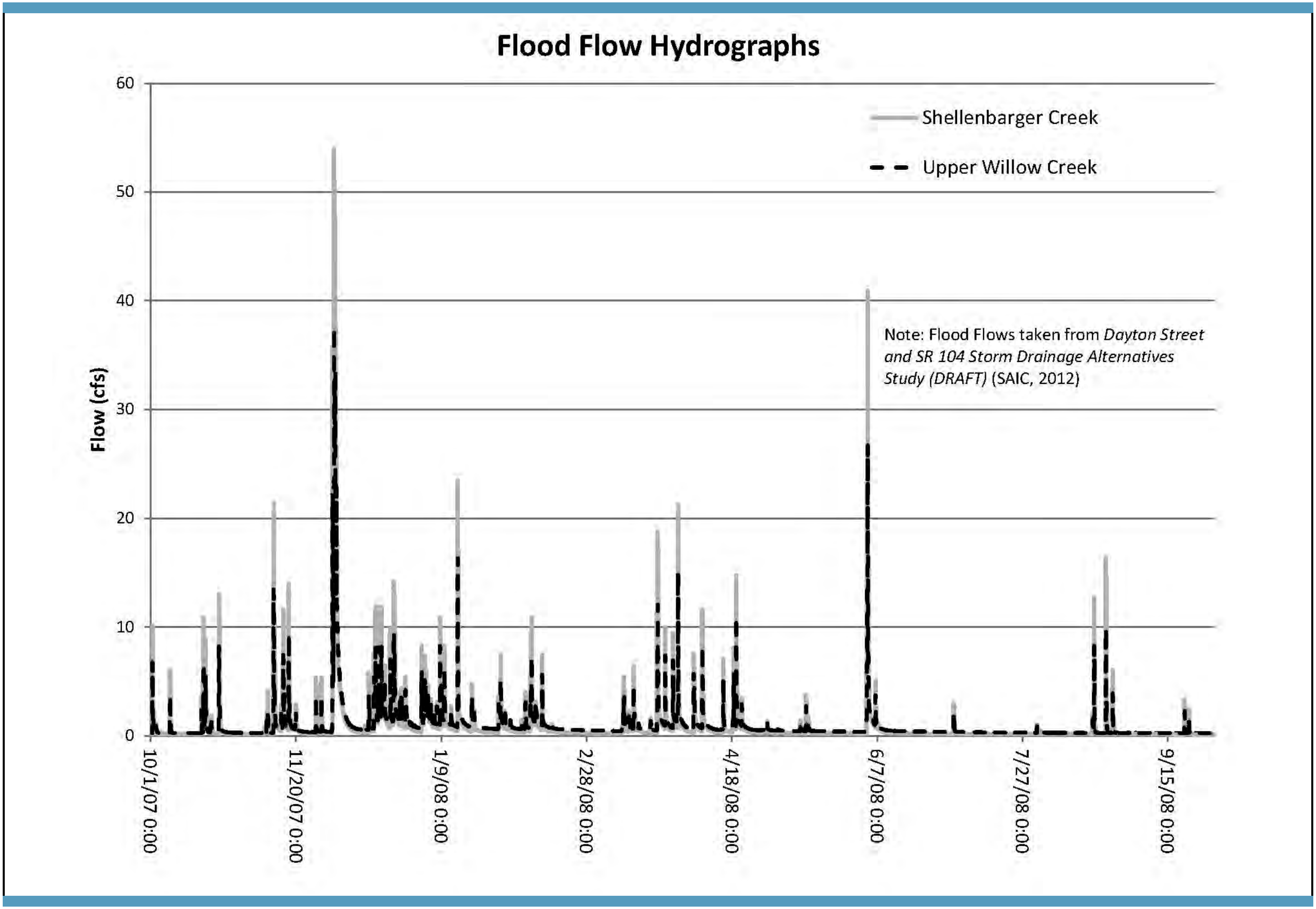


Figure 5
Flood Flow Hydrographs
Tidal Marsh Hydrodynamic Report (DRAFT)
Willow Creek Daylight Early Feasibility Study

NOTES:
Inundation areas based on HEC-RAS maximum water surface model outputs.
Existing surface source: Shannon & Wilson
Aerial source: Bing

Figure 6
Estimated Inundation Areas - Existing Spring Conditions
Tidal Marsh Hydrodynamics Report (DRAFT)
Willow Creek Daylight Early Feasibility Study

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NOTES:
Inundation areas based on HEC-RAS maximum water surface model outputs.
Proposed surface source: Shannon & Wilson
Aerial source: Bing

Figure 7
Estimated Inundation Areas - Proposed Spring Conditions
Tidal Marsh Hydrodynamics Report (DRAFT)
Willow Creek Daylight Early Feasibility Study

NOTES:
Inundation areas based on HEC-RAS maximum water surface model outputs.
Aerial source: Bing

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Figure 8
Comparison of Estimated Inundation Areas - Spring Conditions
Tidal Marsh Hydrodynamics Report (DRAFT)
Willow Creek Daylight Early Feasibility Study

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NOTES:
Aerial source: Bing

Feet
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Figure 9
Approximate Locations of Plotted Velocities
Tidal Marsh Hydrodynamics Report (DRAFT)
Willow Creek Daylight Early Feasibility Study

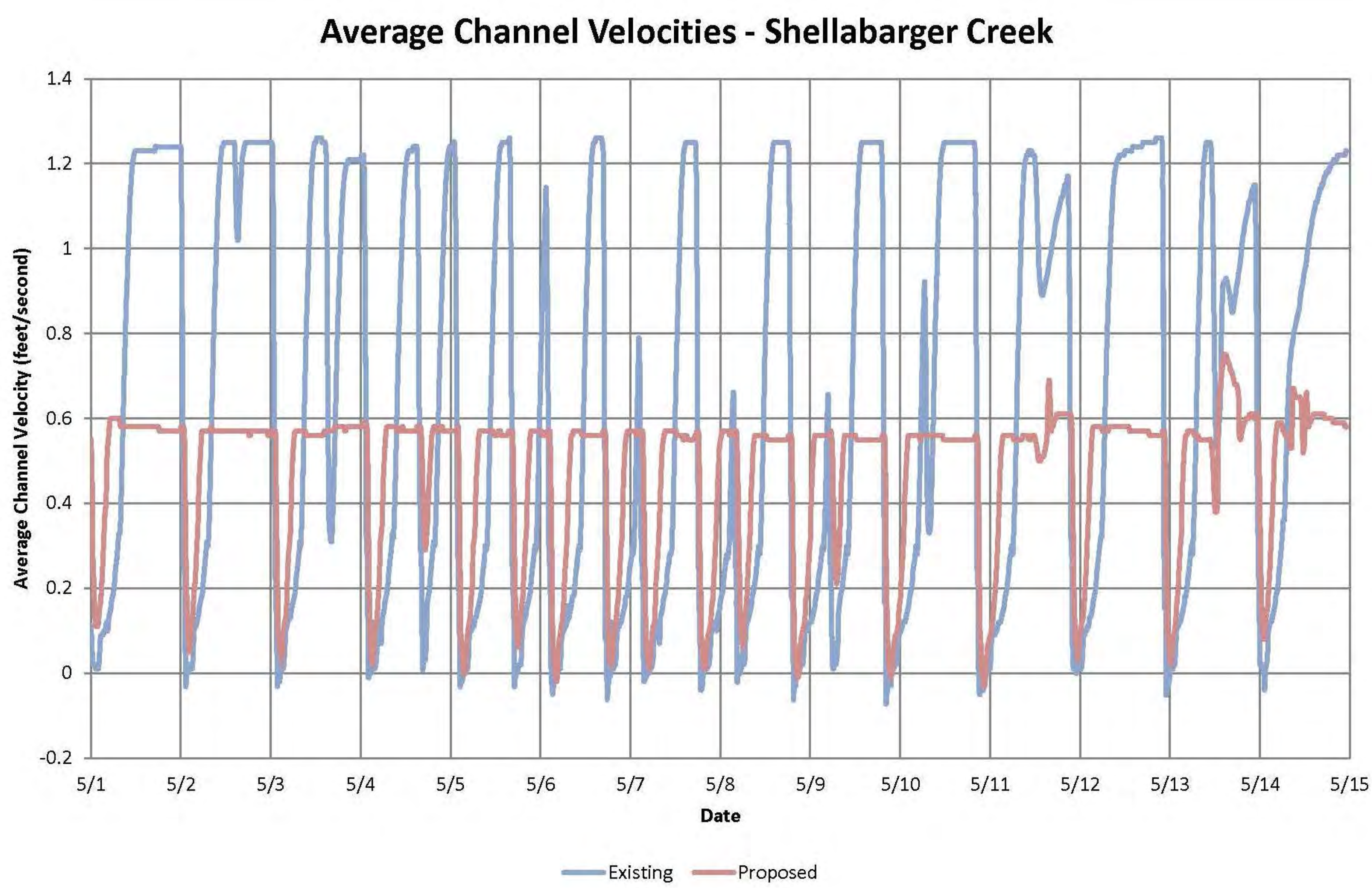

Figure 10
Comparison of Average Channel Velocities: Existing and Proposed Conditions—Shellabarger Creek
Tidal Marsh Hydrodynamic Report (DRAFT)
Willow Creek Daylight Early Feasibility Study

ANCHOR QEA

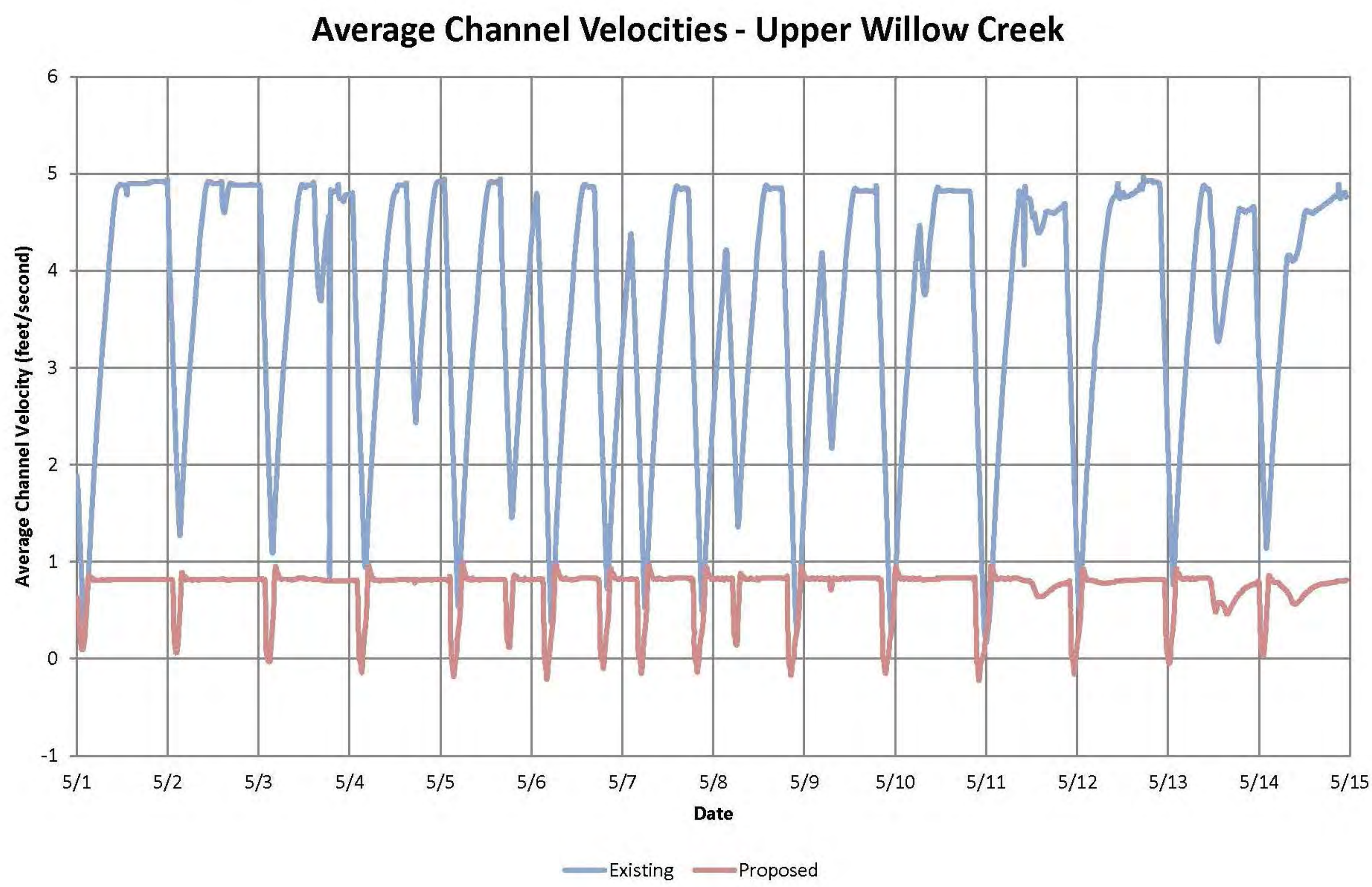

Figure 11
Comparison of Average Channel Velocities: Existing and Proposed Conditions—Upper Willow Creek
Tidal Marsh Hydrodynamic Report (DRAFT)
Willow Creek Daylight Early Feasibility Study

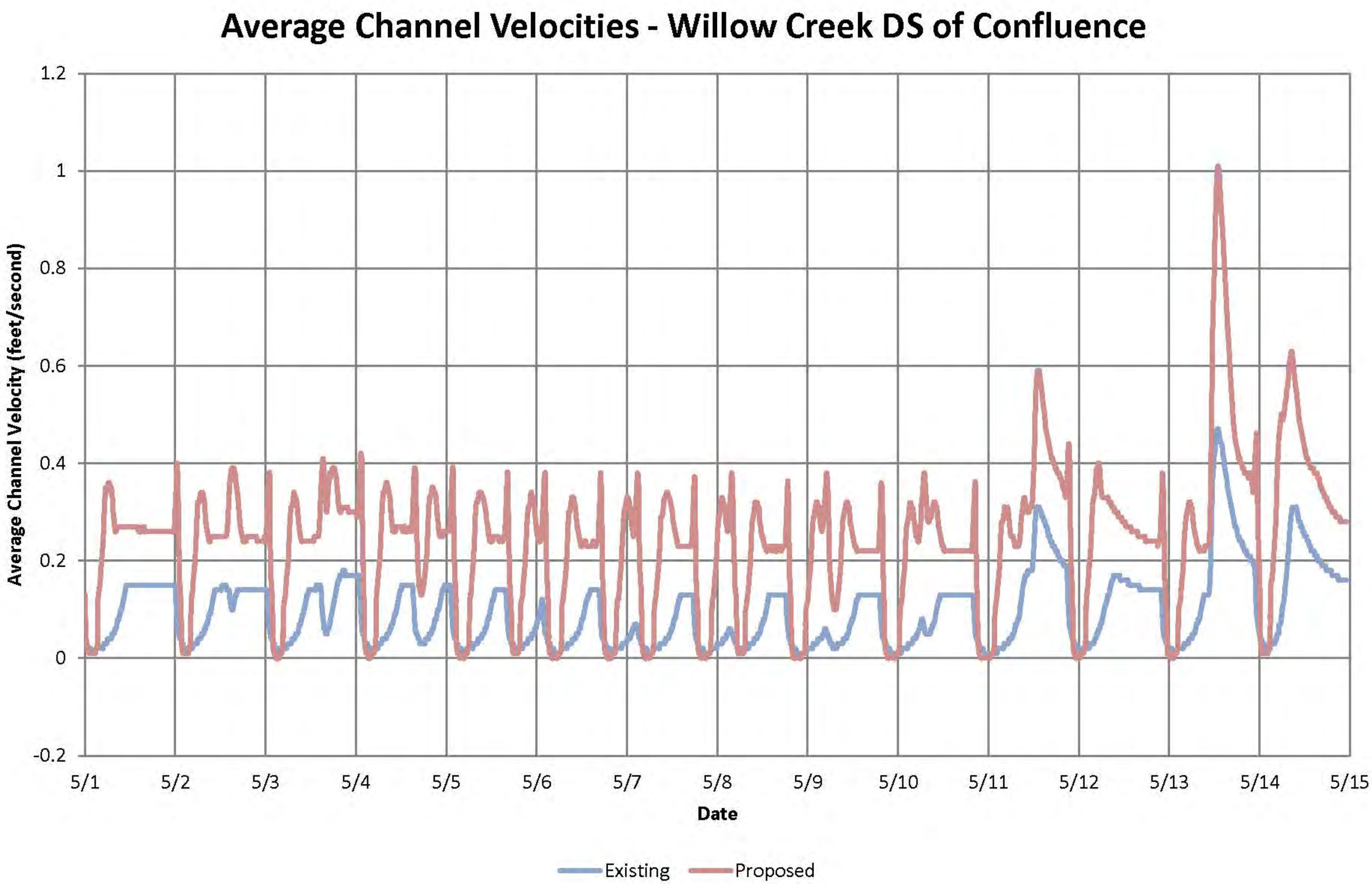

Figure 12

Comparison of Average Channel Velocities: Existing and Proposed Conditions—Willow Creek DS of Confluence
Tidal Marsh Hydrodynamic Report (DRAFT)
Willow Creek Daylight Early Feasibility Study

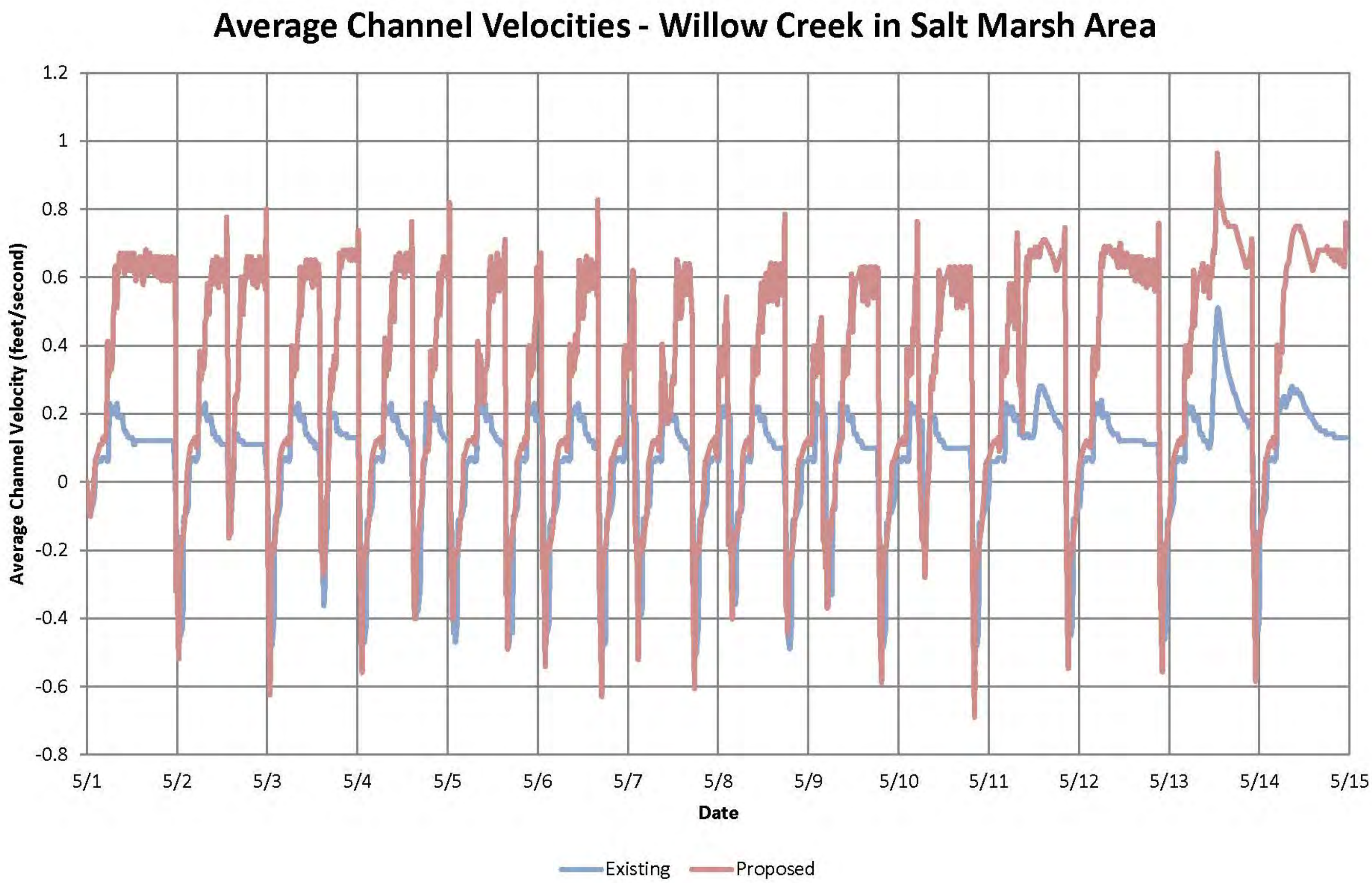

Figure 13
Comparison of Average Channel Velocities: Existing and Proposed Conditions—Willow Creek in Salt Marsh Area
Tidal Marsh Hydrodynamic Report (DRAFT)
Willow Creek Daylight Early Feasibility Study

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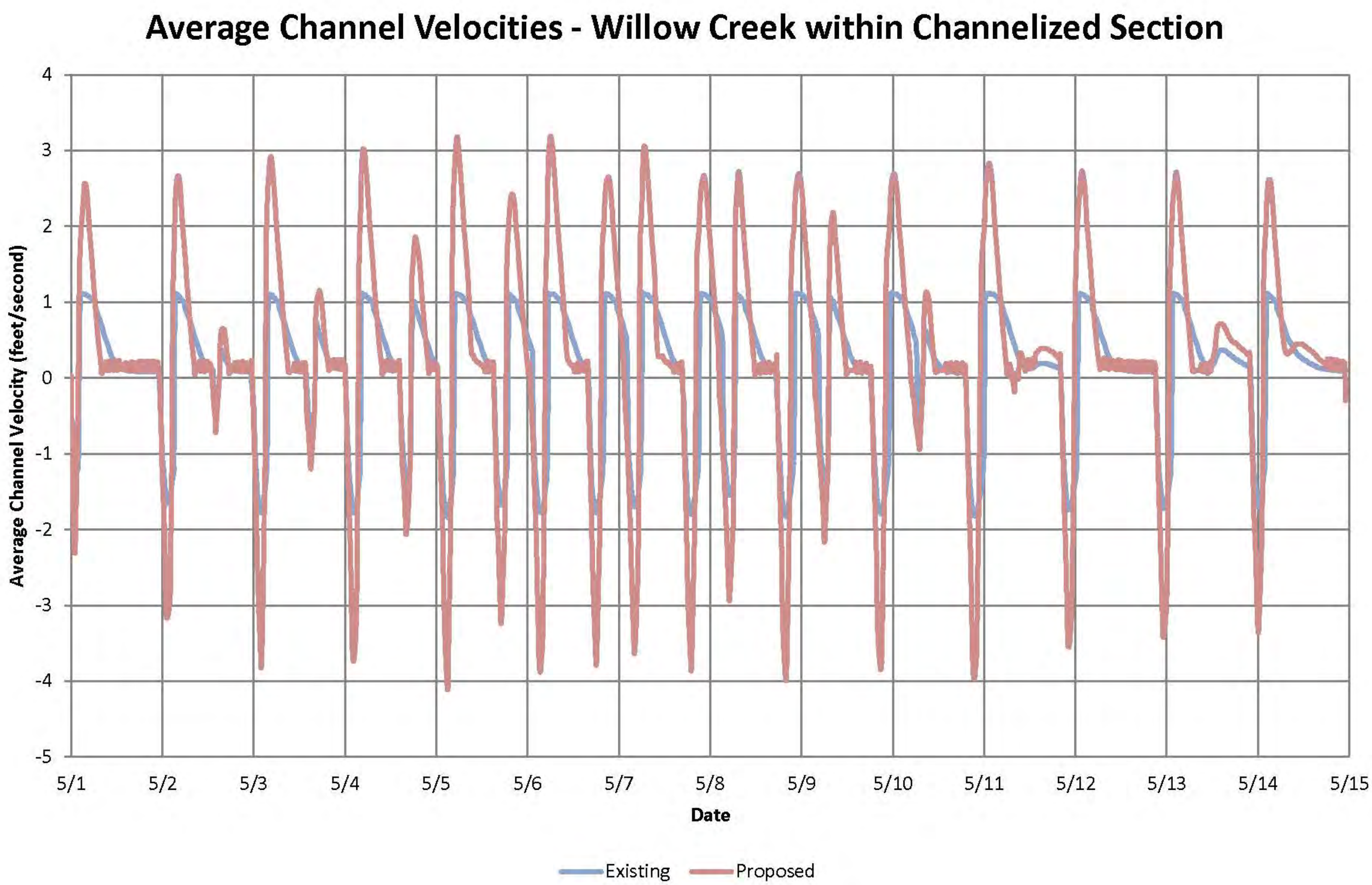


Figure 14
Comparison of Average Channel Velocities: Existing and Proposed Conditions—Willow Creek within Channelized Section
Tidal Marsh Hydrodynamic Report (DRAFT)
Willow Creek Daylight Early Feasibility Study

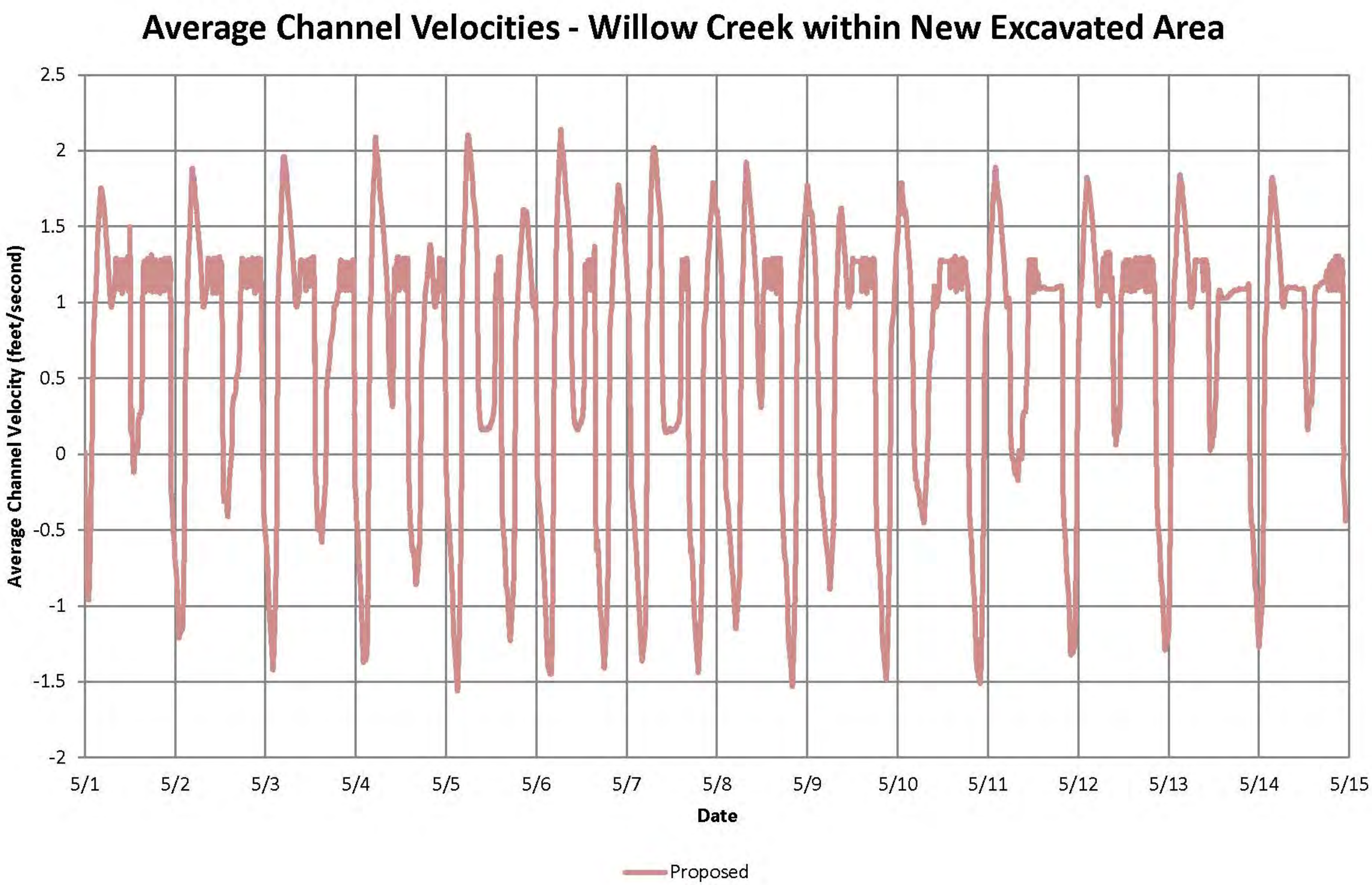


Figure 15

Comparison of Average Channel Velocities: Existing and Proposed Conditions—Willow Creek within New Excavated Area

Tidal Marsh Hydrodynamic Report (DRAFT)

Willow Creek Daylight Early Feasibility Study

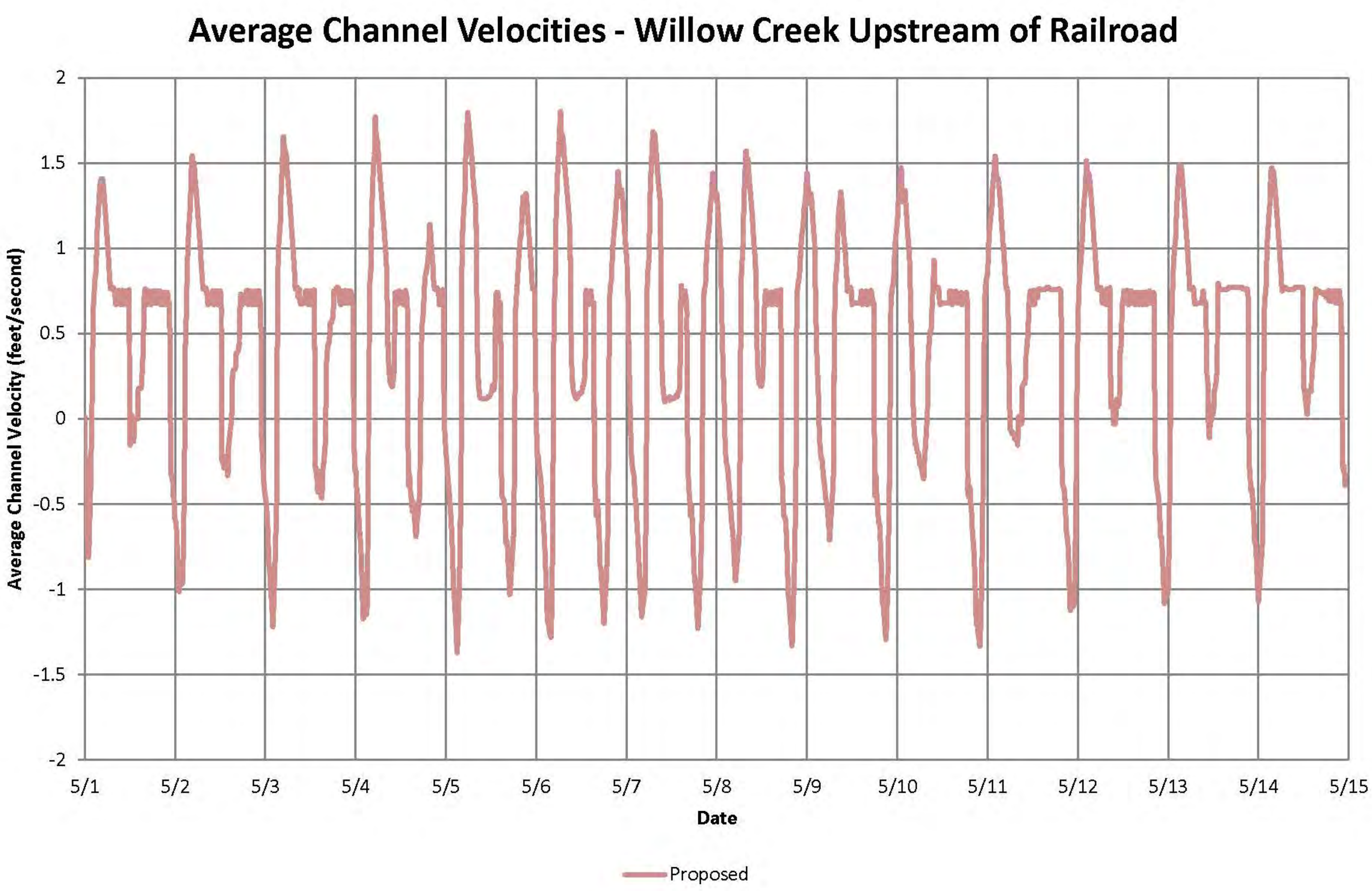


Figure 16
Comparison of Average Channel Velocities: Existing and Proposed Conditions—Willow Creek Upstream of Railroad
Tidal Marsh Hydrodynamic Report (DRAFT)
Willow Creek Daylight Early Feasibility Study

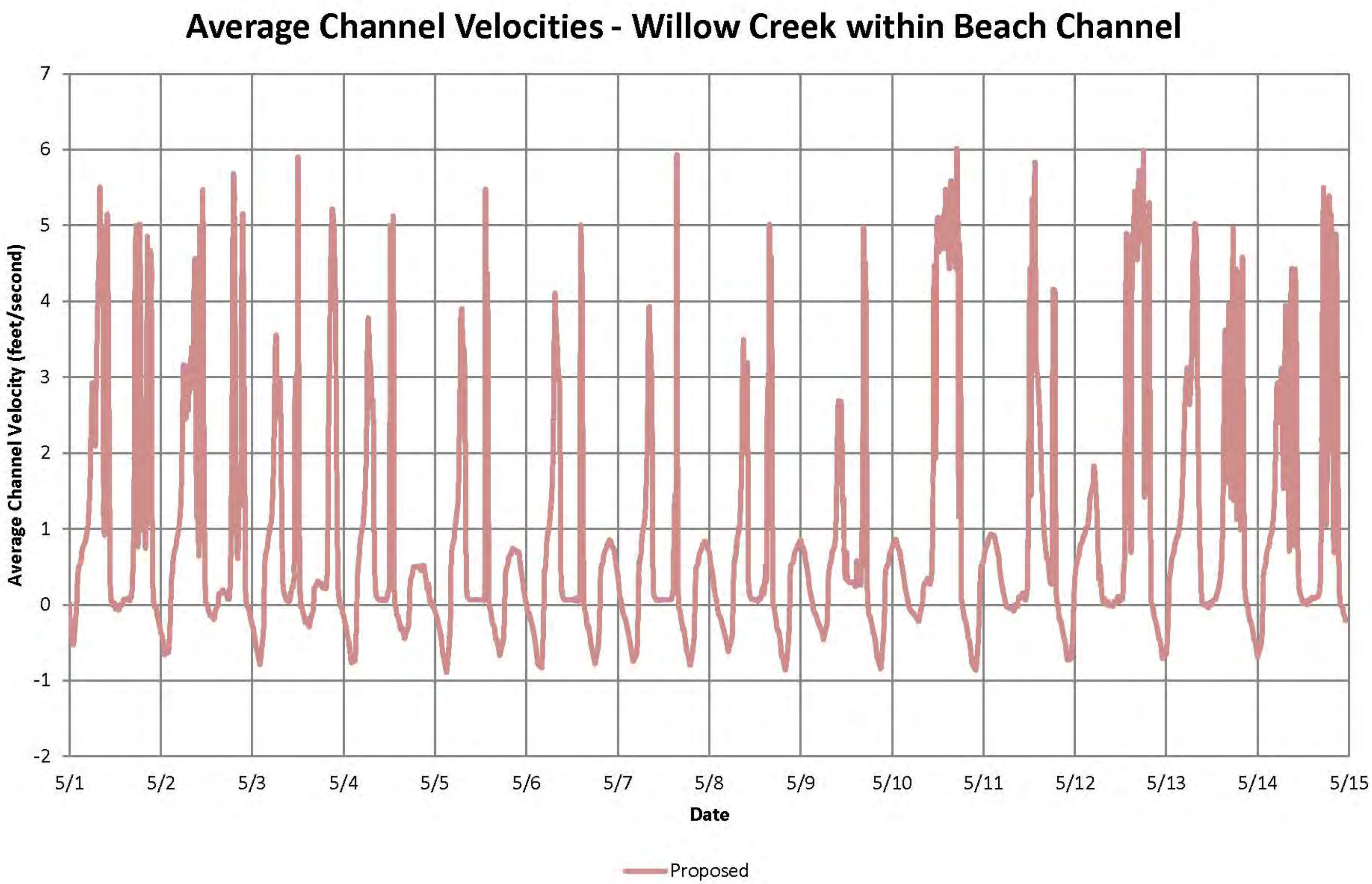


Figure 17
Comparison of Average Channel Velocities: Existing and Proposed Conditions—Willow Creek within Beach Channel
Tidal Marsh Hydrodynamic Report (DRAFT)
Willow Creek Daylight Early Feasibility Study

ANCHOR QEA

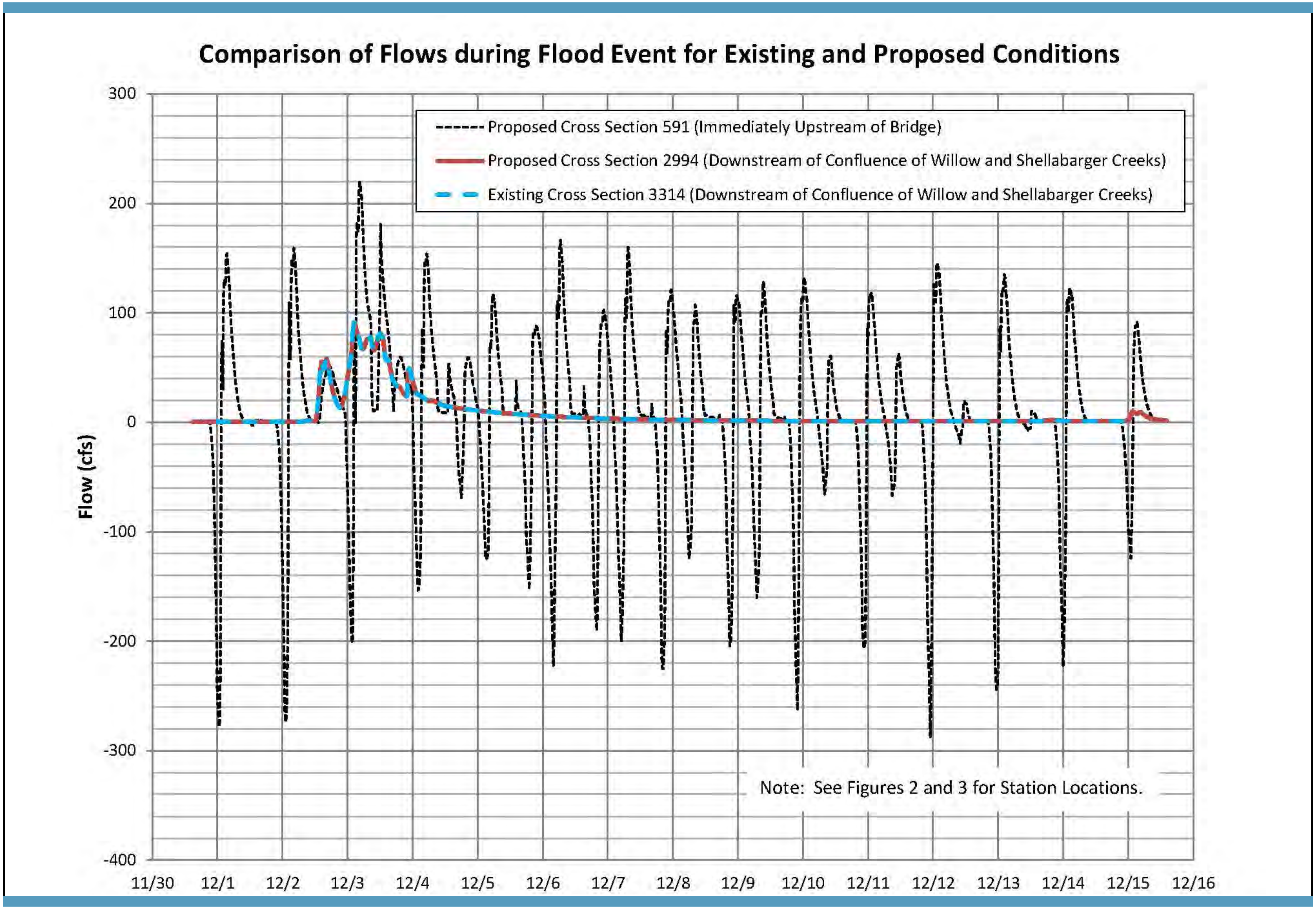


Figure 18
Comparison of Flows during Flood Event for Existing and Proposed Conditions
Tidal Marsh Hydrodynamic Report (DRAFT)
Willow Creek Daylight Early Feasibility Study

ANCHOR QEA

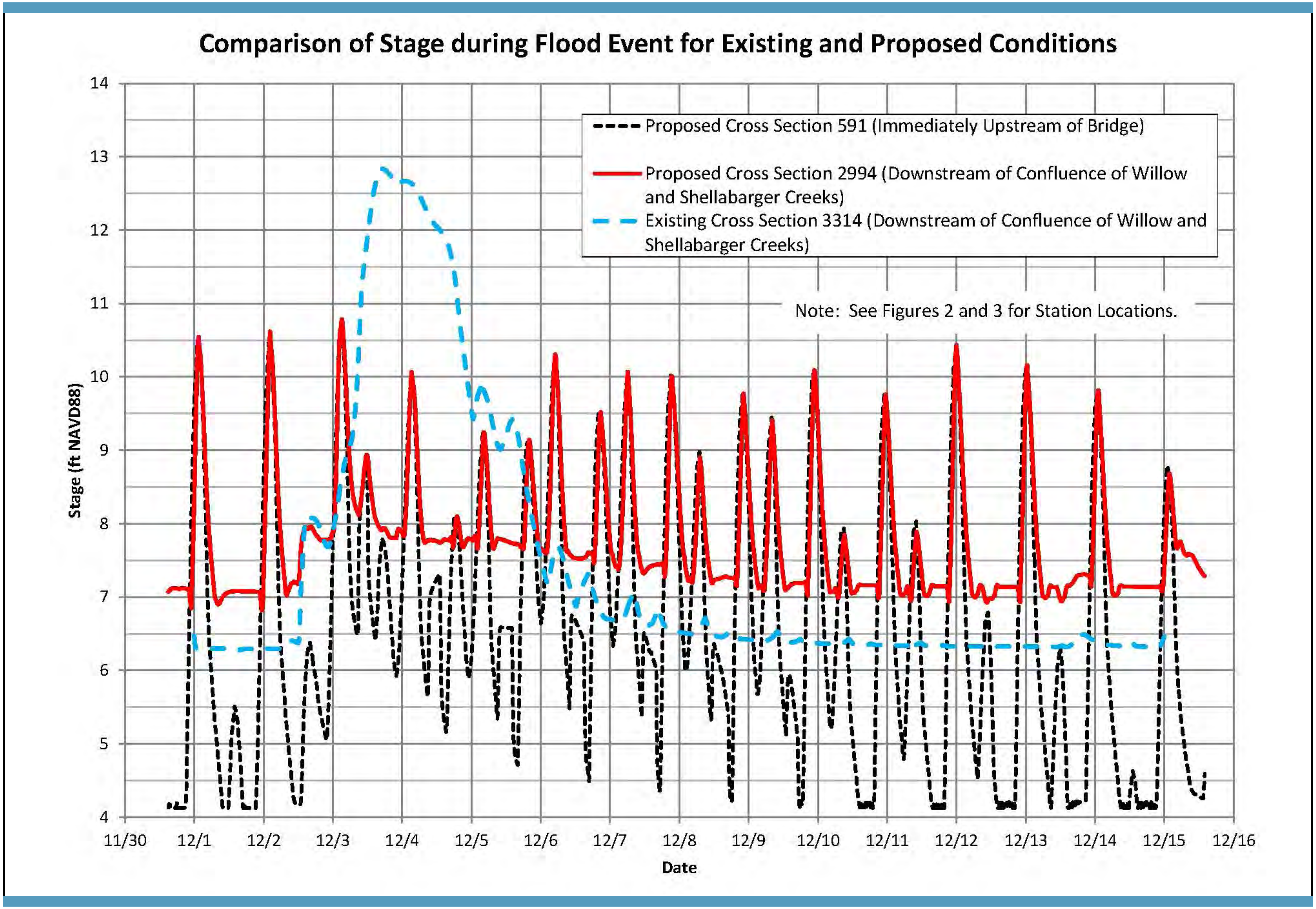
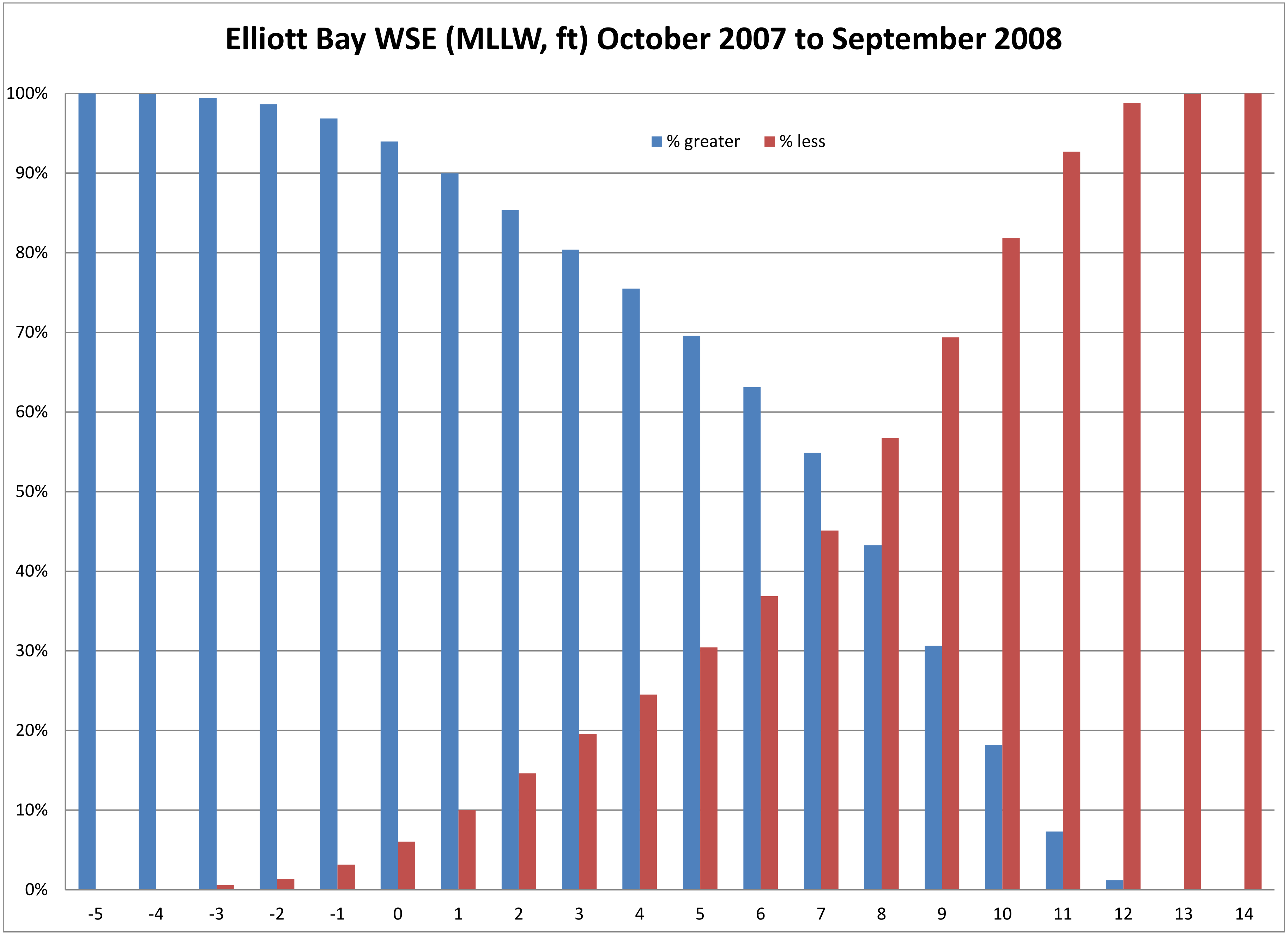
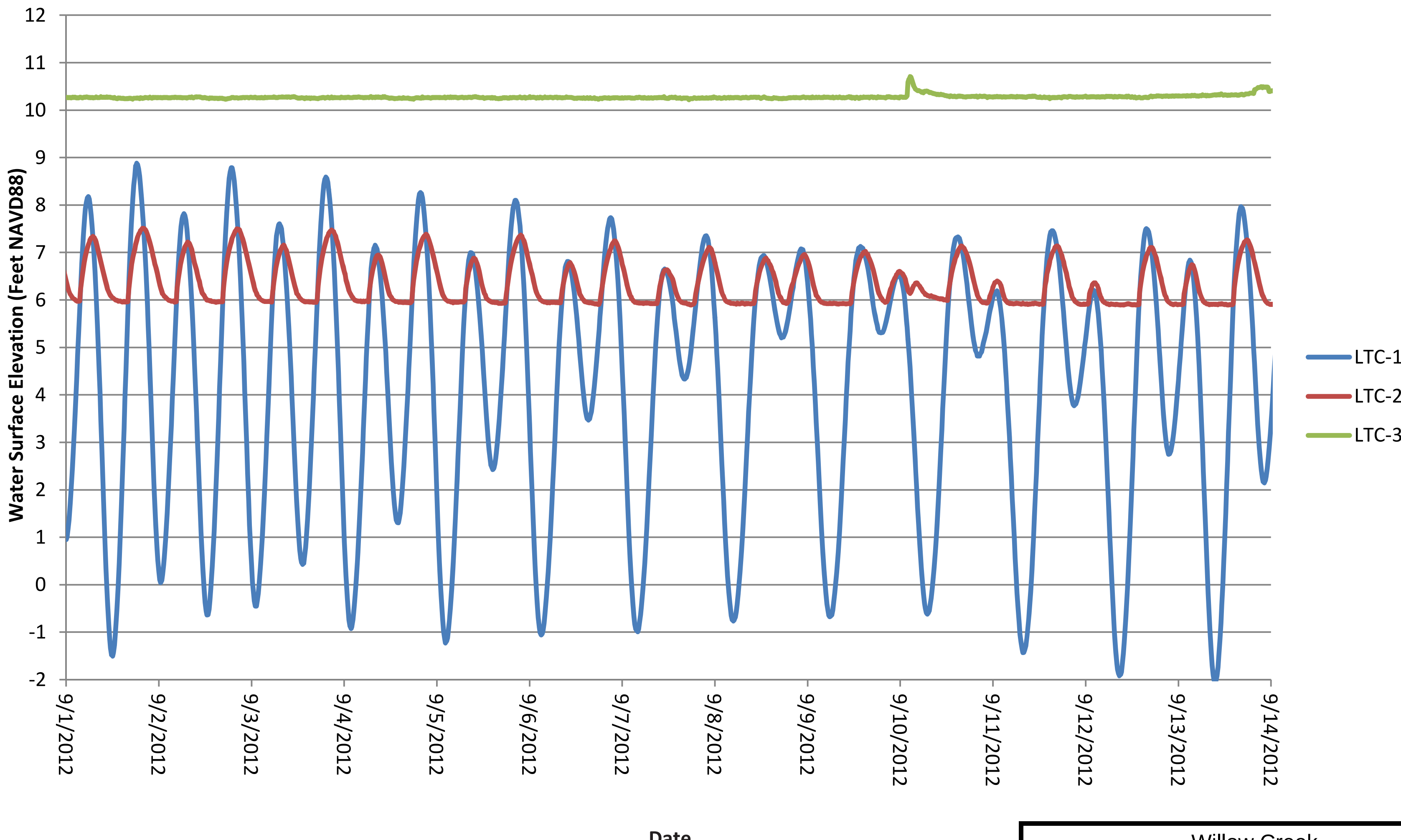


Figure 19
Comparison of Flows during Flood Event for Existing and Proposed Conditions
Tidal Marsh Hydrodynamic Report (DRAFT)
Willow Creek Daylight Early Feasibility Study

ANCHOR QEA

APPENDIX A
WATER LEVEL, SALINITY AND TEMPERATURE DATA PLOTS


Elliott Bay WSE (MLLW, ft) October 2007 to September 2008
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
% greater
% less
-5
-4
-3
-2
-1
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14



Willow Creek

Edmonds, WA

WATER LEVELS
SEPTEMBER 2012

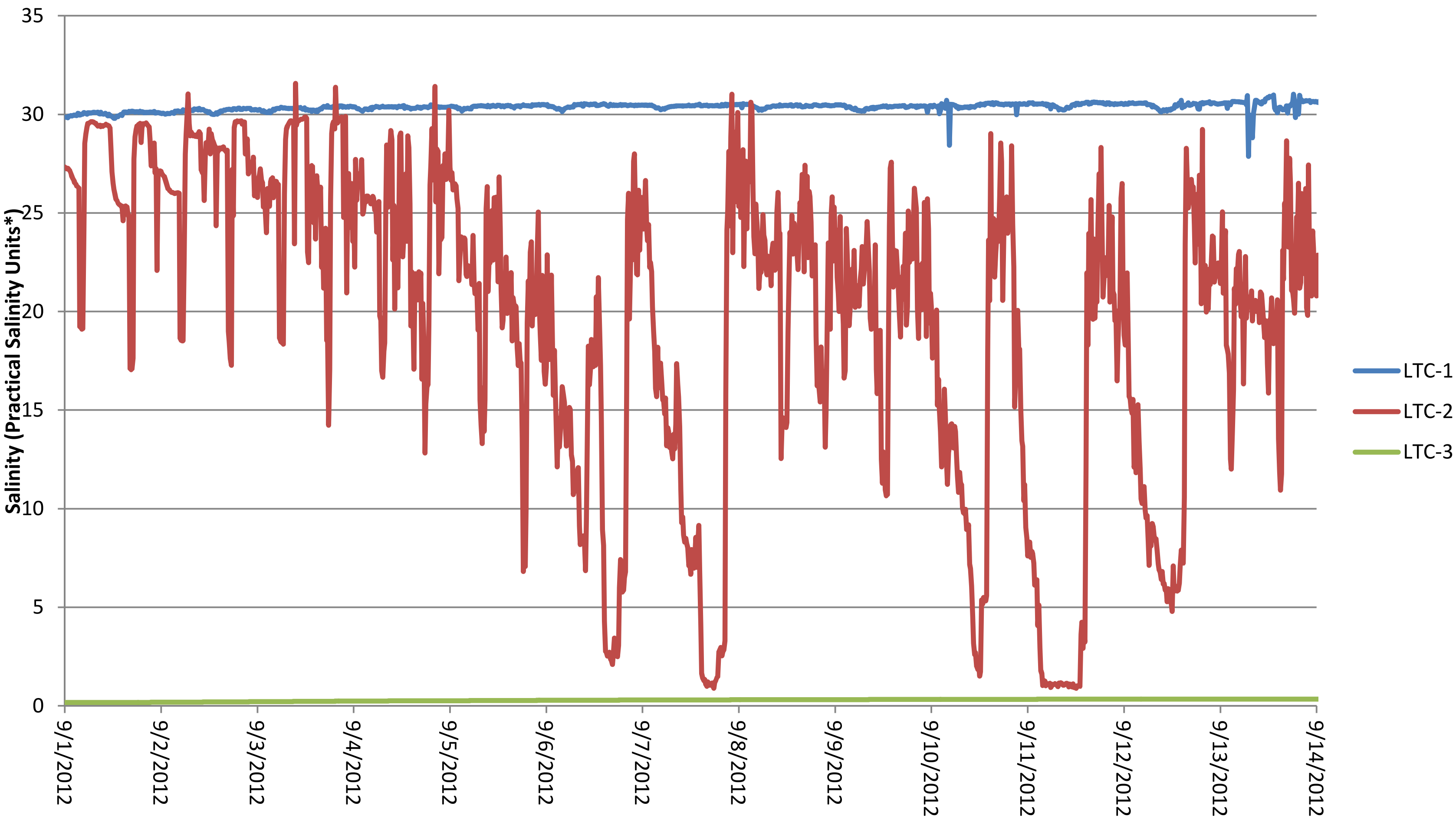
September 2012 | 21-1-12393-102

SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

FIG. 2

FIG. 2

I:\Users\ahill\Public\Willow Creek\WILLOW_CRK_MASTER_20120904 <Chart-WSE>



*Practical Salinity Units (PSU) are approximately equivalent to Parts Per Thousand (ppt)

Date

Willow Creek

Edmonds, WA

SALINITY
SEPTEMBER 2012

September 2012 21-1-12393-102

SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

FIG. 3

FIG. 3

I:\Users\ahill\Public\Willow Creek\WILLOW_CRK_MASTER_20120904 <Chart-Salinity>

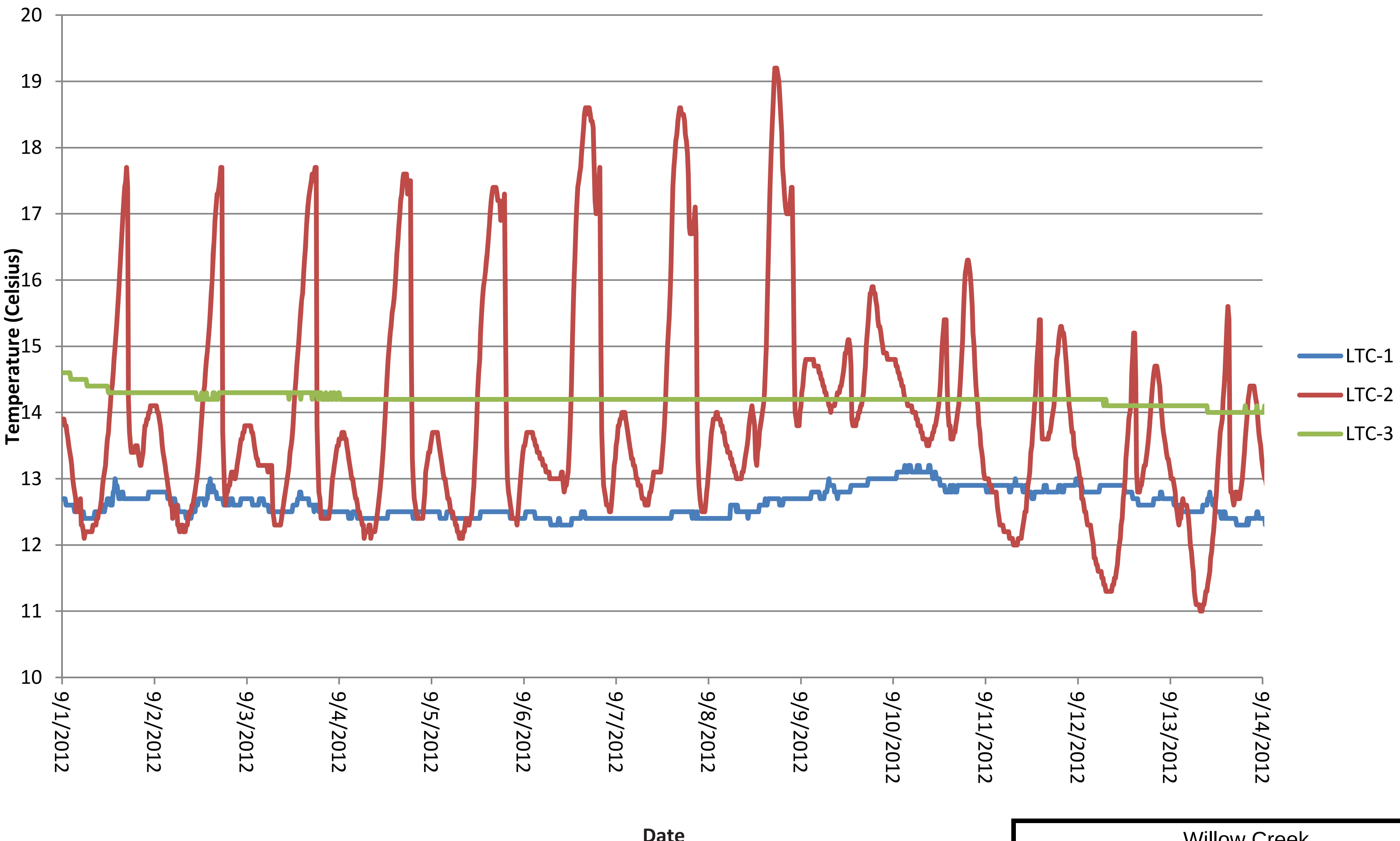


FIG. 4

Willow Creek

Edmonds, WA

TEMPERATURE
SEPTEMBER 2012

September 2012 21-1-12393-102

SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

FIG. 4

I:\Users\ahill\Public\Willow Creek\WILLOW_CRK_MASTER_20120904 <Chart-Temp>

APPENDIX C

TECHNICAL MEMORANDA AND IMPORTANT PROJECT RECORDS

MEMORANDUM

TO: David Cline, PE (Shannon & Wilson, Inc.)
Kathy Ketteridge, PhD, PE (Anchor QEA LLC)

CC: Jerry Shuster (City of Edmonds)
Keeley O'Connell (EarthCorps)
Paul Schlenger (Confluence Environmental)

FROM: Alex Hallenius, PE

DATE: January 7, 2013

RE: WILLOW CREEK STREAM INFLOW AND TIDAL HYDROLOGY BOUNDARY CONDITIONS

This memo summarizes the Willow Creek stream and tidal inflow hydrology information related to the hydraulic modeling for the Willow Creek Early Feasibility Study.

The project survey vertical datum is the North American Vertical Datum of 1988 (NAVD88). Elevations in tidal environments (and from NOAA tidal gauges) are often reported in Mean Lower Low Water (MLLW) datum. For the project, the NAVD88 elevation can be approximated from the MLLW datum by subtracting 2.09 feet. This transformation was calculated using NOAA's VDatum v3.1 computer program. We recommend a professional surveyor confirm this transformation prior to development of project final design plans.

The tidal data from the NOAA Seattle Elliot Bay gage was compared with the LTC-1 logger installed at the Edmonds Marina for the time period September 1 through 14, 2012. There was little noticeable period (time) shift between the locations. In general, the amplitude of the LTC-1 location was diminished compared to the Seattle Elliot Bay tidal data by -0.2 feet. This may be attributable to the breakwater effect of the Edmonds Marina jetty. Therefore, it appears reasonable to use the Elliot Bay tidal data as a boundary condition for the Edmonds Marsh hydraulic modeling tidal boundary conditions. Figure 1 is a graph of the comparison.

Inflow hydrology modeling results, provided from the Dayton St. / SR-104 stormwater study, were reviewed. Based on our review of the modeling data, and information regarding recent historical flooding in the marsh, we recommend a modeling period of October 1, 2007 through September 30, 2008 for the Willow Creek Early Feasibility Study. This period corresponds to an observed flood event in December 2007 that had documented flooding, including overtopping of the Chevron/Unocal stormwater pond banks (Rasar, 2012).

The estimated 100-year flood event flows are 69cfs for Shellabarger at the SR-104 culvert, and 49cfs for Willow Creek at the 216th St. culvert (Geisburt, 2012). Data provided from the Dayton

St. / SR-104 study for the October 2008 through September 2008 period have peaks inflows of 52cfs and 36cfs, for Shellabarger and Willow Creek respectively, which is on the order of a 25-year flood event. We did not identify inflow peak events on the order of the 100-year flood event. Therefore, we recommend using the large storm event of December 2007, with field documentation for flood overtopping of the Chevron stormwater pond as the project design flood hydrology.

Input files were created for the period October 1, 2007 through September 30, 2008. The data is provided in a file named “Boundary Conditions_20130107.xlsx”. The worksheet “Elliot Bay” contains recorded tidal data from the Seattle Elliot Bay tidal gage for the time period, in one-hour time steps. The worksheet “Upstream” contains modeled flows from the SR-104 HSPF model for the time period, in 15-minute time steps. The designations RCH 200 and RCH 300 represent Shellabarger Creek and Willow Creek, respectively. A graph of the upstream boundary conditions is shown in Figure 2.

MEMORANDUM

TO: file

FROM: Alex Hallenius, Bo Lewis

DATE: September 18, 2012 (revised 3-7-2013)

RE: EDMONDS MARSH COMPOSITE EXISTING GIS SURFACE CREATION EDMONDS, WASHINGTON

This memo describes the process used to create a composite GIS TIN surface of the Edmonds Marsh area. File paths are referenced to the Shannon & Wilson network. Project datum is NAVD88.

The following data sources were used to create the composite surface. Data was provided electronically by the client.

- LIDAR-generated contours for marsh area
  - I:\WIP\21-1\12393 Willow Creek Daylight\02. BACKGROUND_REPORTS\DAYTON_SR-104_DATA\MCD\Site Information\2005 Edmonds Lidar contours
  - ArcGIS shapefile, contains contours with elevations
  - Datum: NAVD88
- 2004 Willow Creek channel survey along BNSF ROW (by CH2M Hill?)
  - I:\WIP\21-1\12393 Willow Creek Daylight\02. BACKGROUND_REPORTS\DAYTON_SR-104_DATA\MCD\2004 CH Willow Creek survey\Edmonds_Willow-Creek SURF.dwg
  - AutoCAD Drawing contains 3d faces and contours
  - Datum: NAVD88
- 2008 Marsh Area survey
  - I:\WIP\21-1\12393 Willow Creek Daylight\02. BACKGROUND_REPORTS\DAYTON_SR-104_DATA\MCD\Site Information\Survey\Marsh Topo\Deliverables\XL1981_Vargot01.dgn
  - Microstation Drawing contains points and breaklines
  - Datum: MLLW
- 2012 Perteet survey
  - I:\WIP\21-1\12393 Willow Creek Daylight\02. BACKGROUND_REPORTS\SURVEY\Perteet Survey 2012-6-6.zip
  - AutoCAD drawing contains points and lines of channels in the marsh

- Datum: NAVD88

The following procedure was used to create the composite surface:

- Create Base surface TIN from LiDAR contours in ArcGIS
- Create AutoCAD Civil3d surface from 2004 data, export in *.xml format
- Import 2008 survey data from Microstation to AutoCAD. Create AutoCAD Civil3d surface from data, adjust surface elevation by -2.28 feet for NAVD88 datum. Export in *.xml format.
- Create 3d polylines from 2012 survey data, save in *.dwg format
- Import *.xml files (2) and *.dwg file (1) into ArcGIS.
- Trim areas of overlap between surfaces
- Create composite surface from data.

The surface was spot-checked to verify the transitions between the inserted surfaces.

The final GIS surface is named “2012_Surface_Combined” and is located in: I:\WIP\21-1\12393 Willow Creek Daylight\GIS\Existing_CombinedSurface

MEMORANDUM

TO: file

FROM: Alex Hallenius, Bo Lewis

DATE: March 7, 2013

RE: EDMONDS MARSH PROPOSED CONDITIONS GIS SURFACE CREATION EDMONDS, WASHINGTON

This memo describes the process used to create a composite GIS TIN surface of the Edmonds Marsh area that includes proposed channel grading. File paths are referenced to the Shannon & Wilson network. Project datum is NAVD88.

The following data sources were used to create the composite surface:

- Composite existing ground surface created by Shannon & Wilson on March 5, 2013, and located at: I:\WIP\21-1\12393 Willow Creek Daylight\GIS\Proposed_Grading
- Proposed channel features created in AutoCAD Civil3d to represent grading for:
  - The beach outfall channel and daylight channel
  - Willow creek marsh dredging
  - Shellabarger creek marsh dredging

  The surfaces are located in: I:\WIP\21-1\12393 Willow Creek Daylight\CAD\Proposed Grading_2013_03_01\Proposed_2013_03_01.dwg

The following procedure was used to create the composite surface:

- Start with composite existing ground TIN surface (Existing_CombinedSurface)
- Import *.xml file into ArcGIS using the AcGIS 3D Analyst Extension.
- Trim areas of overlap between surfaces.
- Create composite surface from data.

The surface was spot-checked to verify the transitions between the inserted surfaces. A few cross-sections were cut to compare the existing and proposed surfaces in the marsh area and verify that the surface was created correctly.

The final GIS surface is named “willowcreek_prop_2013_03_05” and is located in: I:\WIP\21-1\12393 Willow Creek Daylight\GIS\Proposed_Grading

APPENDIX C

SOUND TRANSIT – BNSF BRIDGE DESIGN AGREEMENT

WILLOW CREEK BRIDGE FUNDING AGREEMENT

This Funding Agreement is dated June 17, 2010, and is between BNSF Railway Company, a Delaware corporation, with its principal place of business in Fort Worth, Texas ("**BNSF**") and the Central Puget Sound Regional Transit Authority, a Washington regional transit authority organized under RCW 81.112 ("**Sound Transit**").

On December 17, 2003, Sound Transit entered into a Purchase and Sale Agreement with BNSF to purchase commuter rail agreements for the operation of commuter rail trains between Seattle and Everett (that agreement, the Purchase and Sale Agreement).

On December 17, 2003, Sound Transit also entered into a Joint Use Agreement with BNSF to regarding joint operation of freight and commuter rail between Seattle and Everett (that agreement, the Joint Use Agreement).

Federal and State natural resource agencies with jurisdiction over the property where some of the Third Commuter Rail Easement Improvements (as defined in the Joint Use Agreement) will be constructed have required Sound Transit to mitigate for the loss of wetlands and streams filled as a result of such Third Commuter Rail Easement Improvements. One of the required mitigation projects ("Willow Creek Bridge Project") will provide a new two-bridge structure for the future realignment and daylighting of Willow Creek. Under the Joint Use Agreement, Sound Transit is responsible for the incremental cost of any improvements that are constructed for the Willow Creek Bridge Project.

BNSF is willing to construct Sound Transit's Willow Creek Bridge Project as part of its improvements to the Everett to Seattle rail corridor, provided that Sound Transit reimburses BNSF for the incremental costs of additional design and construction.

The parties therefore agree as follows:

1.0 Willow Creek Bridge Project.

1.1 Willow Creek Bridge Project. The Willow Creek Bridge Project will be a new two-bridge structure through the BNSF right of way in the vicinity of Sta 998+50 and as more clearly outlined in **Schedule A.** Work done in furtherance of the Willow Creek Bridge Project by BNSF or its contractors is "Willow Creek Bridge Project Work."

1.2 Services Performed. Willow Creek Bridge Project Work may include, but are not limited to the following:

1.2.1 Furnishing flaggers as necessary in connection with any construction services or activities as outlined below, including all flagging determined by BNSF to be necessary to protect any people and/or property and/or continued train operations on and along the Service Property;

1.2.2 Relocating and realigning any tracks, switches, crossovers and signals that BNSF reasonably determines to be appropriate in connection with construction of the Willow Creek Bridge Project;

1.2.3 Grading and constructing necessary improvements related to the Willow Creek Bridge Project, including structural improvements, retaining walls and Bridges;

1.2.4 Removing and salvaging tracks and/or other improvements, as required to accommodate, or as a result of construction of, the Willow Creek Bridge Project;

1.2.5 Purchasing construction materials, or supplying them from BNSF's own stock, transporting them, storing them;

1.2.6 Relocating fiber optic facilities and other utilities in connection with construction of the Willow Creek Bridge Project; and complying with all applicable environmental, land use and construction permits and conditions in connection with construction of the Willow Creek Bridge Project (including complying with permits and conditions voluntarily accepted by BNSF);

1.2.7 Supervising the activities described in this section and providing regular reports to Sound Transit as reasonably requested by Sound Transit describing progress of the Willow Creek Bridge Project Work and any related issues that arise; and

1.2.8 Billing Sound Transit for the activities described in this section.

1.3 **Willow Creek Bridge Project Cost.** "Willow Creek Bridge Project Cost" includes, but is not limited to, the following incremental costs of constructing the Willow Creek Bridge Project over the project cost for the Third Commuter Rail Easement Improvements:

1.3.1 The cost of construction materials;

1.3.2 The payroll cost for BNSF employees including BNSF's payroll-related administrative costs and applicable additives;

1.3.3 The rental charges for equipment and vehicles used in performing the Willow Creek Bridge Project Work;

1.3.4 The cost of transporting all equipment, personnel, and construction materials to and from field sites as required to perform the Willow Creek Bridge Project Work;

1.3.5 Any costs to BNSF for storage and handling of construction materials or equipment required to perform the Willow Creek Bridge Project Work by a third party;

1.3.6 All applicable state or local taxes (including business and occupation taxes), government assessed fees or assessments by any state or local government authority that are not already included in Sound Transit's, BNSF's or its contractors' rates, but which specifically attributable to the funding or performance of the Willow Creek Bridge Project Work;

1.3.7 The cost of complying with all applicable permits and conditions required by government authorities in connection with construction of the Willow Creek Bridge Project, and permits or conditions that are, or are anticipated to be, voluntarily accepted by BNSF, including cost of filing fees, attorneys' fees and consultants' fees in seeking to contest the application of laws, regulations or ordinances to any aspect of the Work, or in seeking to obtain, modify or demonstrate compliance with any such permit or condition;

1.3.8 The cost of complying with all applicable laws, regulations, court or administrative agency decisions or ordinances;

1.3.9 The cost of performing the duties and obligations of BNSF set forth in Sections 1.3, 2.1 or otherwise in this Agreement;

1.4 **Defined Terms.** Capitalized terms found in this Agreement that are not defined are as defined in the Joint Use Agreement and the Purchase and Sale Agreement.

2.0 General Duties and Obligations.

2.1 BNSF.

2.1.1 BNSF shall construct the Willow Creek Bridge Project in conjunction with its construction of the Third Commuter Rail Easement Improvements and perform the Willow Creek Bridge Project Work provided in section 1.2 and as described in **Schedule A**.

2.1.2 BNSF shall allow Sound Transit the opportunity to participate in the pre-bid and pre-construction meetings.

2.1.3 BNSF shall provide Sound Transit access to the work site for purposes of inspection of the following phases of work. Any additional costs to BNSF due to delayed approval by Sound Transit of work performed, will be reimbursed by Sound Transit:

a. Staking of project limits

b. Installation of necessary Temporary Erosion and Sediment Controls
c. Final grading
d. As-built plan

2.1.4 BNSF will provide Sound Transit with 10 calendar days notice prior to the start of grading activities to allow Sound Transit adequate time to coordinate on-site inspection.

2.1.5 BNSF or the selected contractor will provide documentation depicting the as-built plans showing how the site was ultimately constructed. This will be used for permit compliance. Sound Transit will provide review and approval of the as-built plan.

2.2 **Sound Transit**. Sound Transit shall perform the following:

2.2.1 **Funding.** Fund the Willow Creek Bridge Project as provided in Section 3.0.

2.2.2 **Permits and Approvals.** Acquisitions of Permits and Approvals including Proprietary Permits and Approvals as defined in the Joint Use Agreement.

2.2.3 **Project Oversight.** Sound Transit shall oversee and approve or disapprove of the following Willow Creek Bridge Project Work stages prior to BNSF's initiation of the next phase of construction. Any additional costs to BNSF due to delayed approval by Sound Transit of work performed, will be reimbursed by Sound Transit:

a. Staking of project limits
b. BMP installation
c. Final grading
d. As-built plan preparation

3.0 **Funding for the Willow Creek Bridge Project.**

3.1 **Funding Elements**

3.1.1 **Construction.** Sound Transit shall reimburse BNSF under this Agreement in the amount of not to exceed $920,000.00 for the cost of the Willow Creek Bridge Project plus amounts required to be paid pursuant to Sections 2.1.7, 2.2, 4.1, 6.3, and 7; subject to Section 9.11 of this Agreement.

3.1.2 **Repair and Maintenance.** In lieu of any contribution toward operations, maintenance or repair of the Willow Creek Bridge in the future, Sound Transit shall pay to BNSF $138,400, as detailed in **Schedule B,** upon satisfactory completion of construction of the WCB Project.

3.2 **Invoicing.** BNSF shall submit to Sound Transit, BNSF's standard billing invoice with supporting documentation (as exemplified in the Seattle-Tacoma Construction Agreement of 2000), which sets forth BNSF's costs incurred for the Willow Creek Bridge Project Work the invoice period. BNSF shall send invoices to the following address:

Accounts Payable
Sound Transit
401 S. Jackson St.
Seattle, WA 98104

3.3 **Payment.** Sound Transit shall reimburse BNSF within 30 days of receipt of invoice in compliance with Section 3.2.

3.4 **Increases in Spending**: Notice of excess cost shall be provided by the BNSF to Sound Transit Project Manager a minimum of 60 days to facilitate Sound Transit's review and process to obtain Board authorization for additional expenditures under this Agreement.

4.0 Work Stoppage and Termination.

4.1 **Work Stoppage Requested by Sound Transit.** Sound Transit may order cessation of all Willow Creek Bridge Project Work following delivery of at least ninety (90) days prior written notice to BNSF. If Sound Transit requests a work stoppage, BNSF will cease all Willow Creek Bridge Project Work and close out the Willow Creek Bridge Project Work by performing such additional work as is reasonably necessary to return BNSF's railroad property to an operating condition that is at least as safe and efficient as prior to commencement of the Willow Creek Bridge Project Work. Sound Transit acknowledges that the least expensive alternative in such case may be to complete the Willow Creek Bridge Project Work. Sound Transit shall reimburse BNSF for any costs associated with the work.

4.2 **Work Stoppage Requested by BNSF.** BNSF may stop work on the Willow Creek Bridge Project Work if Sound Transit fails to make timely payment under Section 3.

5.0 Ownership of Real Property and Construction Material.

Sound Transit shall have no ownership interest in any real property or Construction Materials (i.e. tangible items that BNSF uses for construction of the Willow Creek Bridge Project) other than the rights acquired by Sound Transit under the Commuter Rail Easements.

6.0. Reporting Responsibilities.

6.1. Reports and Documentation. Sound Transit may require (1) work statements or payroll records, (2) invoices for materials and supplies, (3) statements from professionals for services rendered, and (4) an itemized listing of the charges supported by copies of original bills, invoices, expense accounts, and miscellaneous supporting data retained by BNSF. Sound Transit represents and warrants that no federal funds will be used to make any payments from Sound Transit to BNSF under this Agreement.

6.2 Availability of Records. All project records in support of all costs incurred and actual expenditures kept by BNSF and its contractors shall be open to inspection by Sound Transit during normal business hours, and shall be retained and made available for such inspection for a period of not less than three years from final payment of funds under this Agreement to BNSF. Copies of these records shall be furnished to Sound Transit. This requirement shall be included in all subcontracts related to the work entered into by BNSF to fulfill the terms of this Agreement.

6.3 Audit. If an audit is requested by Sound Transit, BNSF shall cooperate fully with the auditor chosen by Sound Transit at Sound Transit's expense notwithstanding Section 3.1 of this Agreement. At the time of an audit, if required, BNSF will provide documentation of all costs incurred on the project. In the event that Sound Transit has paid in excess of its final funding commitment under Section 3.1 of this Agreement (exclusive of amounts required to be paid by Sound Transit in addition to the cap listed in Section 3.1), then BNSF will refund to Sound Transit the amounts over-collected within thirty (30) days of the conclusion of the audit. Further, if BNSF had overcharged Sound Transit by more than 5 percent, then BNSF will not be eligible for the reimbursement of the cost of the audit, and will reimburse Sound Transit for Sound Transit's audit costs.

7.0 Inspection and Acceptance.

All of the Willow Creek Bridge Project Work performed by BNSF under this Agreement shall be subject to inspection and reasonable approval by Sound Transit for compliance with its environmental mitigation requirements during the course of the work as provided in section 2.1. BNSF shall upon notice from Sound Transit bring the work into compliance with the applicable standards or specifications or mitigation requirements. If such additional work is beyond the scope of the work described in Schedule A then such work shall be at Sound Transit's expense notwithstanding Section 3.1 of this Agreement. Sound Transit's representatives shall be notified of and included in all scheduled inspections of the Willow Creek Bridge Project Work.

8.0 Termination of Agreement.

This Agreement shall terminate upon the completion of construction and the payment by Sound Transit under the terms of this Agreement. Sound Transit may also terminate this Agreement if BNSF has not moved into the construction phase of the Willow Creek Bridge Project Work by January 1, 2012.

9.0 Miscellaneous

9.1 Entire Agreement. This Agreement and the exhibits that are attached constitute the entire agreement and understanding between Sound Transit and BNSF relating to the subject matter contained herein. There are no restrictions, promises, representations, warranties, covenants or undertakings, oral or otherwise, except those expressly set forth or referenced herein.

9.2 Amendments. No waiver, modification, addition, or amendment to this Agreement shall be of any force or effect unless reduced to writing and signed by the authorized employees of each party hereto.

9.3 Severability. In the event that any term, covenant, condition, or provision of this Agreement, or the application of the Agreement to any person or circumstance, is found to be invalid or unenforceable in any respect, the remainder of this Agreement, and the application of such term or provision to other persons or circumstances nevertheless shall be binding with the same effect as if the invalid or unenforceable provision were originally deleted. The parties hereto agree to bargain in good faith to reform this Agreement or replace any invalid or unenforceable provision with a valid and enforceable provision that comes as close as possible to the intention of the invalid or unenforceable provision.

9.4 Primary Contacts. The principal contacts for each party in the day-to-day dealings of this Agreement are listed in **Schedule C.**

9.5 Notices. Except as otherwise expressly provided in this Agreement, all requests, notices, demands, authorizations, directions, consents, waivers or other communications required or permitted under this Agreement shall be in writing and either shall be: **(i)** delivered in person, **(ii)** deposited postage prepaid in the certified mails of the United States, return receipt requested, **(iii)** delivered by a nationally recognized overnight or same-day courier service that obtains receipts, or (iv) delivered electronically, with confirmation of receipt by telephone, with an original being sent first class mail to the persons listed in **Schedule C.**

9.6 **Rights and Remedies.** The duties and obligations imposed by this Agreement and the rights and remedies available hereunder shall be in addition to and not a limitation of or waiver regarding any duties, obligations, rights and remedies otherwise available by law. No waiver by either party hereto of any default shall affect or impair any right arising from any subsequent default. The failure of either party hereto to insist at any time upon the strict observance or performance of any of the provisions of this Agreement or to exercise any right or remedy provided for in this Agreement shall not impair any such right or remedy nor be construed as a waiver or relinquishment thereof.

9.7 **Benefits.** This Agreement is intended for the sole benefit of the parties to this Agreement. Nothing in this Agreement is intended to give any person or entity, other than the parties any legal or equitable right, remedy, or claim under this Agreement.

9.8 **Preparation.** The parties hereto and their legal counsel have cooperated in the drafting of this Agreement. Accordingly, this Agreement shall be deemed the joint work product of the parties hereto and shall not be construed against either party by reason of such preparation.

9.9 **Counterparts.** This Agreement shall be simultaneously executed in duplicate counterparts, each of which so executed shall be deemed to be an original, and such counterparts together shall constitute one and the same instrument.

9.10 **No Waiver under Other Agreements.** Nothing in this Agreement is intended to amend or waive any obligation of Sound Transit pursuant to the Joint Use Agreement. In the event of an inconsistency between the terms of this Agreement and the Joint Use Agreement, the terms of the Joint Use Agreement shall prevail.

9.11 **Force Majeure.** BNSF will be excused from performance of any of its obligations in this Agreement, where such non-performance is caused by any event beyond BNSF's reasonable control, which may include, without limitation, an order, rule, or regulation of any federal, state, or local government body, agency, or instrumentality; work stoppage or labor dispute resulting in a strike; extraordinary unavailability of essential materials from third-party suppliers; accident; natural disaster, an act of war or terrorist attack, or civil disorder, inclement weather or unforeseen physical conditions existing on the Service Property ("**Force Majeure Event**"); provided that BNSF shall use all reasonable efforts to minimize its non-performance and to overcome, remedy, or remove such Force Majeure Event in the shortest practical time.

The authorized representatives of BNSF and Sound Transit are signing this Agreement on the date stated in the introductory clause.

Central Puget Sound Regional
Transit Authority

By: Joan M. Earl
Title: Chief Executive Officer

Approved as to form:

Legal Counsel

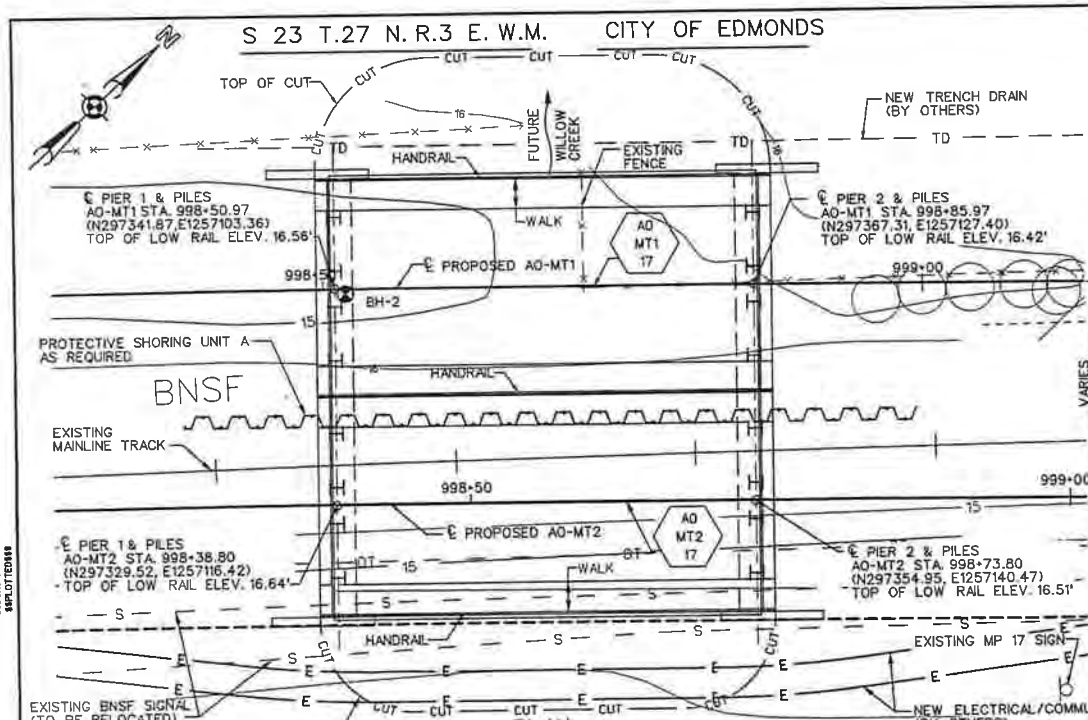
BNSF Railway Company

6/21/10

By: DAVID L. FREEMAN
Title: VP - ENGINEERING

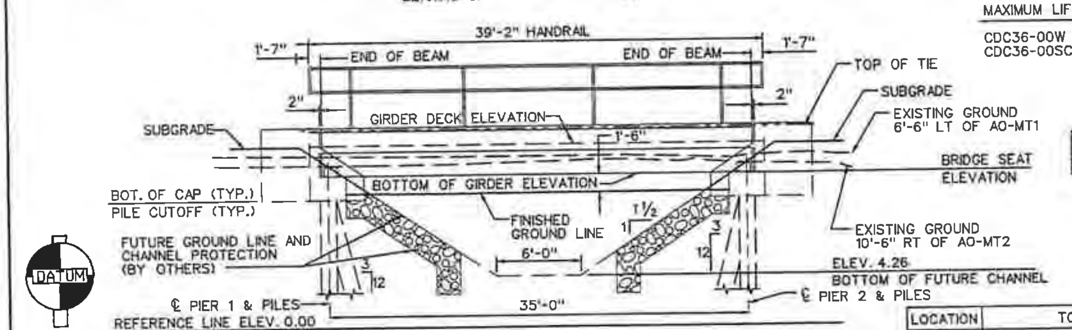
SCHEDULE A

Willow Creek Bridge Project Plans and Specifications
Dated May 20, 2010



PLAN

BEARING OF ALL PIERS S 46° 36' 18" E



ELEVATION - SINGLE SPAN BRIDGE

MAXIMUM LIFTING WEIGHTS

CDC36-00W - 64,000 LBS.
CDC36-00SCW - 61,800 LBS.

CALL TWO FULL BUSINESS DAYS BEFORE YOU DIG

1-800-424-5555

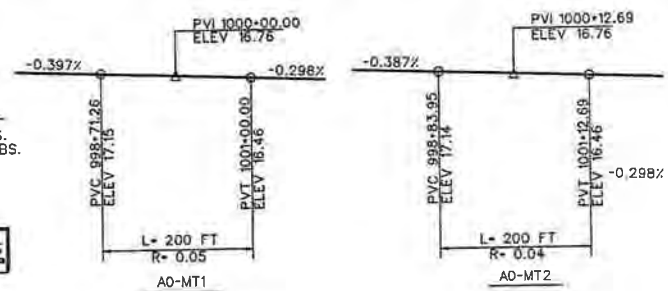
GENERAL NOTES:

1. ALL MATERIAL AND WORKMANSHIP SHALL BE IN ACCORDANCE WITH THE REQUIREMENTS OF THE CURRENT PLANS AND CONTRACT DOCUMENTS.
2. A GEOTECHNICAL INVESTIGATION HAS BEEN CONDUCTED, A REPORT PREPARED AND IS ATTACHED AS AN APPENDIX TO THE SPECIFICATIONS.
3. THE BRIDGE SHALL BE CONSTRUCTED USING 30" X 7'-0" PRESTRESSED CONCRETE DOUBLE BOX BEAMS IN ACCORDANCE WITH THE FOLLOWING BNSF STANDARD PLANS, AND THE GEOMETRY AND MODIFICATIONS SHOWN ON THESE PLANS:

STANDARD PLAN NO.	SHEET NO.	STANDARD PLAN NO.	SHEET NO.
500000 BG1	1 OF 3	0000-17902-088	13 OF 24
500000 BG2	2 OF 3	0000-17902-091	16 OF 24
500000 BG3	3 OF 3	0000-17902-094	19 OF 24
0000-17902-076	1 OF 24	0000-17902-095	20 OF 24
0000-17902-077	2 OF 24	0000-17902-099	24 OF 24
0000-17902-078	3 OF 24	0000-17000-01B	1 OF 1

OTHER STANDARD PLANS AS APPLICABLE AND APPROVED BY THE ENGINEER.

4. THE BEAM ARRANGEMENT SHALL BE IN ACCORDANCE WITH THE TYPICAL SECTION ON DRAWING BR3.
5. PILES SHALL BE H-PILES WITH MATERIALS AS SPECIFIED IN THE BNSF STANDARD SPECIFICATIONS AND STANDARD PLANS, AND DIMENSIONS AS SHOWN IN THESE PLANS.
6. THE CONTRACTOR SHALL BE RESPONSIBLE FOR THE STABILITY OF THE STRUCTURE DURING CONSTRUCTION. TEMPORARY SUPPORTS AND FALSEWORK SHALL BE GRADUALLY RELEASED TO PREVENT IMPACT OR UNDUE STRESSES IN THE STRUCTURE.
7. THE LOCATIONS OF ALL EXISTING UTILITIES WITHIN THE VICINITY OF THE STRUCTURES SHALL BE VERIFIED BY THE CONTRACTOR PRIOR TO EXCAVATING OR DRIVING PILES.
8. UNLESS OTHERWISE NOTED IN THE PLANS, ALL DIMENSIONS ARE HORIZONTAL AND VERTICAL BASED ON A TEMPERATURE OF 64 DEGREES F (MEAN TEMPERATURE DURING CONSTRUCTION).
9. FOR TRACK ALIGNMENT GEOMETRY SEE BNSF EDMONDS DRAWING NO'S P207-P208 AND P216-P217.
10. SHORING SHALL BE DESIGNED AND CONSTRUCTED IN ACCORDANCE WITH THE LATEST EDITION OF THE BNSF "GUIDELINES FOR TEMPORARY SHORING".
11. FOR SURVEY CONTROL AND BENCHMARK ELEVATIONS AND LOCATIONS, SEE BNSF EDMONDS DRAWING G206.



PROFILE GRADE

PROFILE SHOWN IS AT TOP OF LOW RAIL

BRIDGE ELEVATION TABLE

* ELEVATION IS AT TOP OF TIE AT LOW RAIL

LOCATION	TOP OF TIE*	GIRDER DECK	BOT. OF GIRDER	BRIDGE SEAT	BOT. OF CAP/PILE CUTOFF
PIER 1	16.56 (AO-MT1)*, 16.64 (AO-MT2)*	15.17	12.67	12.60	10.60
PIER 2	16.42 (AO-MT1)*, 16.51 (AO-MT2)*	15.17	12.67	12.60	10.60

5/20/2010

CONSULTANT		DATE
DESIGNED BY	V BACURIN	04-02-10
ENTERED BY	V BACURIN	04-02-10
CHECKED BY	K LINTS	04-02-10
PROJ. MGR.	K LINTS	04-02-10

ISSUE: NO. | DATE | BY | DESCRIPTION

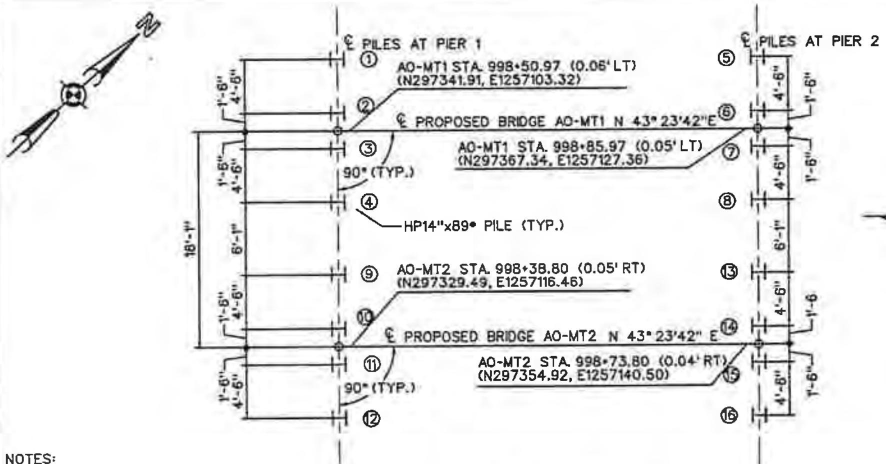
BNSF APPROVALS: DEPARTMENT | SIGNATURE | DATE

AECOM
10900 NE 8th Street, Suite 750
Bellevue, Washington 98004
Phone: (425) 454-5600 Fax: (425) 454-0220

BNSF RAILWAY

FINAL DESIGN
FOR SOUND TRANSIT COMMUTER RAIL
SEATTLE TO EVERETT, WASHINGTON
GRADING AND STRUCTURES
BRIDGE LAYOUT
LS 50, BR.16.90

DWG NO BR1
SHEET 1 OF 4 SHEETS



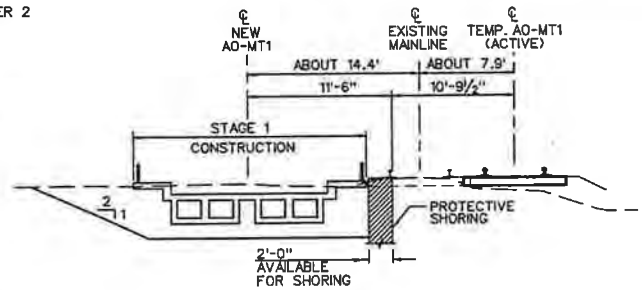
PILE LAYOUT

NOTES:

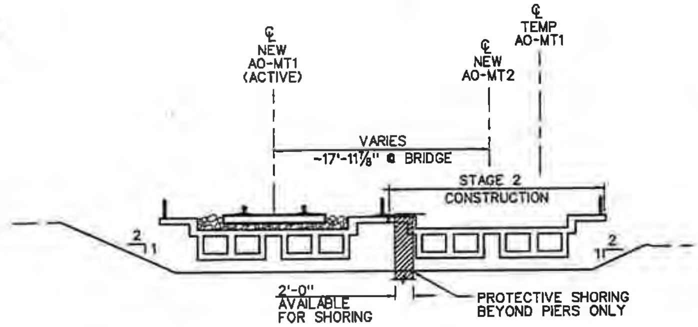
1. PILES SHALL BE DRIVEN BATTERED, AS SHOWN ON DRAWING BR4.
2. PILE LOCATIONS SHOWN ARE AT THE BOTTOM OF THE CAP BEAM.
3. ESTIMATED PILE EMBEDMENT IS 36 FEET BELOW THE BOTTOM OF THE CAP BEAM.

PILE COORDINATE TABLE

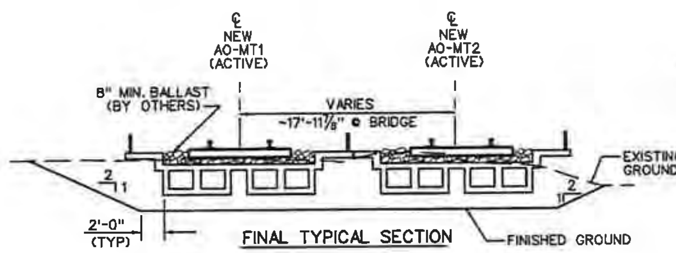
PILE NO.⊙	NORTHING	EASTING
1	297346.03	1257098.96
2	297342.94	1257102.23
3	297340.88	1257104.41
4	297337.79	1257107.68
5	297371.46	1257123.00
6	297368.37	1257126.27
7	297366.31	1257128.45
8	297363.22	1257131.72
9	297333.61	1257112.10
10	297330.52	1257115.37
11	297328.46	1257117.55
12	297325.36	1257120.82
13	297359.04	1257136.14
14	297355.95	1257139.41
15	297353.89	1257141.59
16	297350.80	1257144.86



STAGE 1



STAGE 2



FINAL TYPICAL SECTION

BRIDGE STAGING
LOOKING NORTH (RR EAST)

STAGE 1 CONSTRUCTION:

1. CONSTRUCT AO-MT1 SUBGRADE IN TEMPORARY LOCATION (BY OTHERS).
2. SHIFT EXIST MAINLINE TRACK AND TRAFFIC TO TEMPORARY AO-MT1 (BY BNSF).
3. CONSTRUCT PROTECTIVE SHORING.
4. EXCAVATE AND CONSTRUCT BRIDGE AT PROPOSED AO-MT1.

STAGE 2 CONSTRUCTION:

1. CONSTRUCT AO-MT1 SUBGRADE (BY OTHERS).
2. CONSTRUCT AO-MT1 TRACK AND SHIFT TRAFFIC FROM TEMP. AO-MT1 TO AO-MT1 (BY BNSF).
3. REMOVE PROTECTIVE SHORING BETWEEN PIERS 1 & 2. PROTECTIVE SHORING BEYOND PIERS TO REMAIN.
4. REMOVE AO-MT2 TRACK AT BRIDGE (BY BNSF).
5. EXCAVATE AND CONSTRUCT BRIDGE AT PROPOSED AO-MT2.
6. CONSTRUCT AO-MT2 SUBGRADE (BY OTHERS).
7. REMOVE REMAINING PROTECTIVE SHORING.

FINAL:

1. CONSTRUCT PROPOSED AO-MT2 AND INSTALL TRACK ACROSS BRIDGE (BY BNSF).
2. OPEN AO-MT2 TO TRAFFIC (BY BNSF).

5/20/2010

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DESIGNED BY	V BACURIN	04-02-10							
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PROJ. MGR.	K LINTS	04-02-10							

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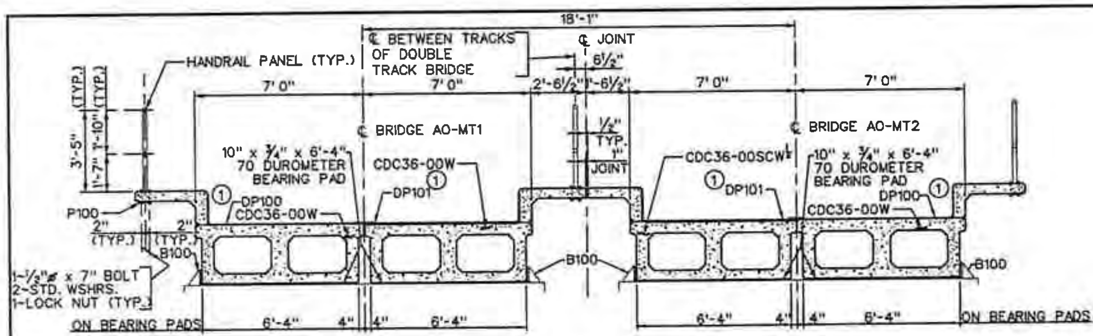
BNSF RAILWAY

FINAL DESIGN
FOR SOUND TRANSIT COMMUTER RAIL
SEATTLE TO EVERETT, WASHINGTON
GRADING AND STRUCTURES
PILE LAYOUT AND CONSTRUCTION STAGING
LS 50, BR.16.90

DWG ID BR2
SHEET 2 OF 4 SHEETS

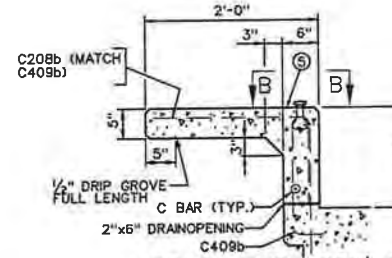


TYPICAL SECTION

LOOKING NORTH

① IF GAP, EITHER BETWEEN BEAMS OR BETWEEN BEAM AND PARAPET, IS ANTICIPATED TO BE GREATER THAN 3", USE DP104 & DP105 IN PLACE OF DP100 & DP101, RESPECTIVELY. ORDER DP104 & 105 ONLY AS NEEDED.

* SEE SPECIAL CURB SCW^L DETAIL ON THIS SHEET



NOTE: SEE BNSF-UP STANDARD PLAN SHEET 500000 BG1 FOR VIEW B AND BNSF-UP STANDARD PLAN SHEETS 500000 BG1, BG2, & BG3 FOR ADDITIONAL DETAILS

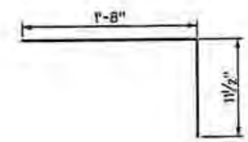
SPECIAL CURB SCW^L DETAIL

PRECAST CURB SCW^R IS OPPOSITE HAND OF SCW^L

⑤ 3"x6" I.D. PLATE IS TO BE EMBEDDED FLUSH IN TOP OF CURB AND CENTERED 6" FROM END OF CURB. PLATE SHALL CONTAIN THE FOLLOWING INFORMATION IN ½" LETTERING: ITEM NAME, LENGTH, WEIGHT, DATE MANUFACTURED AND NAME OF MANUFACTURER.

BILL OF MATERIAL (SEE NOTE 1)

LINE	QTY.	UNIT	DESCRIPTION	MARK	SIZE	LENGTH	REMARKS
1	71,200	LBS.	STEEL BEARING PILE ASTM A36 (16 PIECES)		HP14X89	50'-0"	SEE NOTE 2
2							
3	4	EA.	PRECAST CONC. CAP - END BENT	CPC3W	3'-0"x5'-11¾"	18'-3"	PER DWG BR4 & PLAN 17902-090
4	4	EA.	PRECAST CONC. WINGWALL	PW103	9"x5'-11¾"	8'-6"	PER PLAN 17902-091
5	1	EA.	PRESTRESSED DOUBLE BOX BEAM WITH CUSTOM SPECIAL CURB	CDC36-00SCW^L	2'-6"x7'-0"	36'-0"	PER PLAN 500000 & DWG BR3
6	3	EA.	PRESTRESSED DOUBLE BOX BEAM WITH WALK	CDC36-00W	2'-6"x7'-0"	36'-0"	PER PLAN 500000
7							
8	16	EA.	SPIRAL BOLT		1/4" DIA.	1'-1"	PER PLAN 17902-078
9	16	EA.	WASHER, GALVANIZED	W100	4"x¾"	0'-4"	PER PLAN 17902-094
10	4	EA.	DECK PLATE, GALVANIZED	DP100	8"x⅜"	7'-9½"	PER PLAN 17902-094
11	4	EA.	DECK PLATE, GALVANIZED	DP101	8"x⅜"	7'-9½"	PER PLAN 17902-094
12							
13	8	EA.	RESTRAINER BRACKET	B100	PC OF HP14x89		PER PLAN 17902-094
14							
15	3	EA.	HANDRAIL PANEL, GALVANIZED	EHPM19-6.75	½" DIA. PIPE	19'-6¾"	PER PLAN 17000-001B
16	3	EA.	HANDRAIL PANEL, GALVANIZED	EPHF19-6.75	½" DIA. PIPE	19'-6¾"	PER PLAN 17000-001B
17	12	EA.	PLATE, GALVANIZED	P100	½"x¼"	0'-6"	PER PLAN 17902-094
18							
19	24	EA.	BOLT, HEX HEAD, GALVANIZED		½" DIA.	0'-7"	HANDRAIL POST
20	48	EA.	STANDARD WASHER FOR ½"⌀ BOLT, GALVANIZED		½" DIA.		HANDRAIL POST
21	24	EA.	LOCK NUT FOR ½"⌀ BOLT, GALVANIZED		½" DIA.		HANDRAIL POST
22							
23	8	EA.	URETHANE BEARING PAD - 70 DUROMETER		¾"x10"	6'-4"	PER PLAN 17902-077
24							
25	32	EA.	PREMOLDED JOINT FILLER, ASPH. IMPREG.		½"x28"	6'-4"	PER PLAN 17902-078



BAR C308b

SIZE IS #4

NOTE: FOR BAR DESIGNATION, SEE BNSF-UP STANDARD PLAN 500000 BG2.

NOTES:

1. BNSF TO FURNISH BRIDGE ITEMS SHOWN IN ABOVE BILL OF MATERIAL. IT IS THE RESPONSIBILITY OF THE CONTRACTOR TO PROVIDE PILE DRIVING, PILE SPLICES (IF NECESSARY), PAINT, AND ALL OTHER MATERIALS NOT LISTED IN THE ABOVE BILL OF MATERIALS TO PROPERLY ERECT THIS BRIDGE IN ACCORDANCE WITH THESE PLANS, SPECIAL PROVISIONS, AND BNSF STANDARD CONSTRUCTION SPECIFICATIONS.
2. ESTIMATED PILE EMBEDMENT PER GEOTECHNICAL REPORT RECOMMENDATION IS 36'-0" BELOW THE BOTTOM OF THE CAP BEAM. CONTRACTOR SHALL BE PREPARED TO SPLICE PILES OR USE LONGER PILES AS REQIRED TO DEVELOP REQUIRED PILE CAPACITY.

5/20/2010

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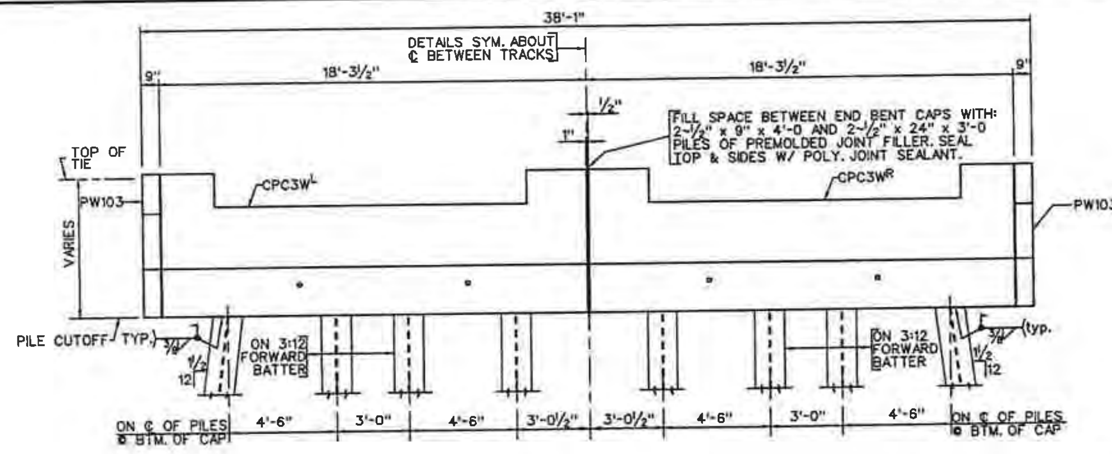
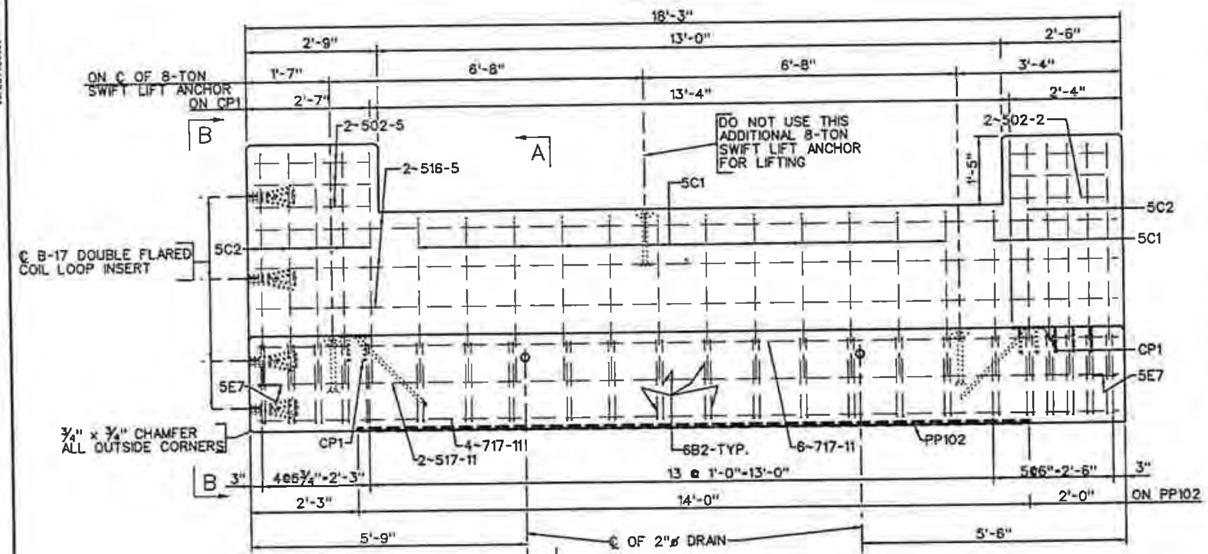
BNSF RAILWAY

FINAL DESIGN
FOR SOUND TRANSIT COMMUTER RAIL
SEATTLE TO EVERETT, WASHINGTON
GRADING AND STRUCTURES
PRECAST MEMBER DETAILS
LS 50, BR.16.90

DWG NO BR3
SHEET 3 OF 4 SHEETS



END BENT



NOTE:
SEE BNSF STD. PLAN SHEET 17902-091
FOR SECTION A-A AND VIEW B-B

PRECAST CAP CPC3W^L

WT.= 23,800 LBS., VOL.= 5.88 CU. YDS., REINF. STEEL= 1,440 LBS.
PRECAST CAP CPC3^R IS OPPOSITE HAND OF CPC3^L

NOTES:

ALL PILES ARE HP14" x 89# STEEL BEARING PILES SEE BNSF STD. PLAN SHEET 17902-088 FOR "TYPICAL PILE SPLICE" DETAIL.

AFTER PRECAST CONCRETE MEMBERS ARE SET, FILL RECESSES AT LIFT ANCHORS WITH CEMENT GROUT TO TOP OF SURROUNDING CONCRETE.

GENERAL ALL MATERIAL AND WORKMANSHIP SHALL BE AS PER THE CURRENT BNSF STANDARD SPECIFICATIONS.

COIL LOOP INSERTS ARE TO BE DOUBLE FLARED TYPE B17 1¼" DIA. x 12" AS MANUFACTURED BY DAYTON-SUPERIOR AND HAVE A SAFE WORKING LOAD OF 13,500 LBS. WITH A 4 TO 1 SAFETY FACTOR. THE INSERTS ARE TO BE COMPLETELY RECESSED WITH 1¼" DIA. x 13" SPIRAL BOLTS ATTACHED TO THE CAP FOR SHIPMENT.

CONCRETE: THE ULTIMATE COMPRESSIVE STRENGTH OF CONCRETE SHALL BE NOT LESS THAN 4000 P.S.I. IN 28 DAYS. CONCRETE MEMBERS SHALL NOT BE REMOVED FROM THE CASTING BED BEFORE THE CONCRETE REACHES A STRENGTH OF 2500 P.S.I.

ALL EXPOSED EDGES OF CONCRETE MEMBERS SHALL BE CHAMFERED ¾".

REINFORCEMENT: MILD STEEL REINFORCEMENT SHALL MEET THE REQUIREMENTS OF THE CURRENT A.S.T.M. DESIGNATION: A615 OR A706, GRADE 60.

FABRICATION OF REINFORCEMENT SHALL BE IN ACCORDANCE WITH CHAPTER 7 OF THE CURRENT C.R.S.I. MANUAL OF STANDARD PRACTICE.

STEEL REINFORCEMENT MAY BE MOVED SLIGHTLY SO AS TO MISS PP102 OR CP1.

MINIMUM CONCRETE COVER ON REINFORCEMENT SHALL BE TWO (2) INCHES.

STEEL REQUIRED PER PRECAST MEMBER

PRECAST MEMBER		DESCRIPTION
CPC3W^L	CPC3W^R	
		REINFORCING STEEL
46	46	6B2 (SEE DETAIL, BNSF STD. PLAN 0000-17902-092)
13	13	5C1 (SEE DETAIL, BNSF STD. PLAN 0000-17902-092)
10	10	5C2 (SEE DETAIL, BNSF STD. PLAN 0000-17902-092)
2	2	5E7 (SEE DETAIL, BNSF STD. PLAN 0000-17902-092)
6	6	502-2 (STRAIGHT, SIZE: #5, LENGTH: 2'-2")
6	6	502-5 (STRAIGHT, SIZE: #5, LENGTH: 2'-5")
8	8	517-11 (STRAIGHT, SIZE: #5, LENGTH: 17'-11")
10	10	717-11 (STRAIGHT, SIZE: #7, LENGTH: 17'-11")
		STRUCTURAL STEEL
4	4	1¼" x 12" DAYTON SUPERIOR B-17 DOUBLE FLARED COIL LOOP INSERT 1¼" x 12" LONG, 13,500 LBS. SWL (SAFE WORKING LOAD), PLAIN
3	3	8-TON SWIFT LIFT ANCHOR
2	2	PLATE CP1 (SEE DETAIL, BNSF STD. PLAN 0000-17902-094)
1	1	PILE PLATE PP102 (SEE DETAIL, BNSF STD. PLAN 0000-17902-094)

5/20/2010

CONSULTANT		DATE	NO.	DATE	BY	ISSUE DESCRIPTION	BNSF APPROVALS DEPARTMENT	SIGNATURE	DATE
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BNSF RAILWAY

FINAL DESIGN
FOR SOUND TRANSIT COMMUTER RAIL
SEATTLE TO EVERETT, WASHINGTON
GRADING AND STRUCTURES
BRIDGE TYP. SECTION & END BENT DETAILS
LS 50, BR.16.90

DWG NO BR4
SHEET 4 OF 4 SHEETS

BNSF RAILWAY

FINAL DESIGN SERVICES FOR SOUND TRANSIT WILLOW CREEK PROJECT

CONTRACT DOCUMENT AND SPECIFICATIONS

RTA/CP 95-07

5/21/10
ISSUED FOR BID

Prepared by

AECOM

10900 NE 8th Street, Suite 750
Bellevue, WA 98004

KIVA LINTS
STATE OF WASHINGTON
39878
STRUCTURAL ENGINEER
PROFESSIONAL ENGINEER
5/21/2010

<u>Sound Transit</u>
Willow Creek Project

TABLE OF CONTENTS

PART 2
INSTRUCTION TO BIDDERS

PART TWO

INSTRUCTIONS TO BIDDERS

2.5 Bonds

Simultaneously with the delivery of the executed Contract, the successful Bidder shall furnish to the Company, in a form satisfactory to the Company, a fully executed performance bond and a fully executed labor and material payment bond, as required by the Company pursuant to the terms of the General Contract to be underwritten and kept in force at the cost and expense of the Contractor, which shall be placed with such sureties as may be acceptable to the Company in a penal sum of not less than the full amount of the Contract price, as security for the faithful performance of this Contract. Those companies holding certificate of authority as acceptable sureties on federal bonds and as published in the Federal Register for the current year is acceptable to the Company.

2.6 Power of Attorney

Attorneys in fact who sign Bid bonds, performance or labor and material bonds must file with each bond a certified copy of their power of attorney to sign said bonds.

Willow Creek

BID PROPOSAL

DATE ______________________

To BNSF Railway Company (hereinafter called "BNSF")

1. The undersigned (hereinafter called the "Bidder") submits this proposal in compliance with your invitation for work necessary to be done on the BNSF's Final Design for Sound Transit Commuter Rail Seattle to Everett, Washington Grading and Structures for the following locations:

   Willows Creek Project

   Having carefully examined the Contract Documents and the site of the proposed Work, and being familiar with all of the conditions surrounding the construction of the proposed Project including the availability of materials and labor, hereby proposes to furnish all labor and materials and supplies and to construct the Project in accordance with the Contract Documents and within the time set forth herein. This price covers all expenses incurred in performing the Work required under the Contract documents of which this Proposal is part. Quantities shown in this Unit Price Bid Proposal and in Alternates, if any, are estimated and actual payment will be made on the basis of confirmed quantities as constructed.

   A. Completion in no more than [**XXX months**] from Notice to Proceed:

      1) Base Bid: ______________________________ Dollars ($____________)

2. The Bidder agrees that the right is reserved by BNSF to delay the Notice to Proceed of a Contract for a period of 180 days. The undersigned agrees to hold firm on the above Bid prices and may not withdraw the Proposal for that period of time. The Bidder agrees that the right is reserved by BNSF to reject any and all Bids.

3. The undersigned Bidder hereby proposes and agrees, if the Bid is accepted, to enter into Agreement in the form attached to perform all Work, including the assumption of all obligations, duties, and responsibilities necessary to the successful completion of the Contract and furnishing of all materials and Work, tools, equipment, supplies, transportation, facilities, labor, superintendence, and services required to perform the Work; and Bonds, insurance, and submittals; all as indicated or specified in the Contract Documents to be performed or furnished by the Bidder.

4. If awarded the Contract, the undersigned hereby agrees to sign said Contract and furnish the necessary insurance certificates and bonds within 10 days of the award of said Contract, not including Sundays and legal holidays, and to begin Work within 10 days after Notification to Proceed.

CONTRACT SE BID PROPOSAL- Willow Creek

Pay Item No.	Item Description	Pay Unit	Qty	Unit Price	Amount
	01000 – GENERAL CONDITIONS				
IB.01	Performance Bond	LS	1		
IB.02	Labor and Material Payment Bond	LS	1		
1505.01	Mobilization	LS	1		
1505.02	Demobilization	LS	1		
	02000 – SITEWORK				
2025.01	Reinforced Filter Fabric Fence	LF	700		
2025.02	Construction Entrance	SF	750		
	03000 – EARTHWORK				
3200.01	Structure Excavation	CY	250		
	04000 - STRUCTURES				
4100.01	Protective Shoring – Unit A	LS	1		
4510.01	Crushed Surfacing Base Course	TN	60		
4200.01	Steel Bearing Pile Driven	LF	576		
4520.01	Bridge Installation	LS	1		
4520.02	Crane Mobilization for Bridge Component Unloading	EA	2		
6000.01	County Tax Rate 9.5%				

CONTRACT SE TOTAL MANDATORY BASE BID

____
(In Words)

DOLLARS & CENTS

____
(In Words)

END OF BID PROPOSAL

NOTES TO BID SCHEDULE

1. The Contractor is hereby reminded that the above Pay Items listed in this Proposal are the only items for which the Contractor will receive payment under this Contract. BNSF Railway will NOT provide payment to the Contractor for ancillary work that may be needed to complete the Project. BNSF Railway will NOT provide payment for work that may or may not be shown on the drawings or covered in the specifications but is not explicitly included in the bid schedule. Payment for any such work should be considered incidental to the various items listed as Bid Proposal Pay items, and no direct payment shall be made thereof. The contractor must complete the work as shown on the drawings and as covered in the specifications.

2. In the event that lesser or greater quantities of specific Pay Items are required to complete the construction, the total amount for Bid specific items will be adjusted by the unit price bid to actual quantities utilized as stipulated in the Proposal. In the event that an error is made in extending unit prices, the Contractor is hereby notified that the unit prices, as Bid, will govern in determining the Total Base Bid.

3. Bidders agree that the right is reserved by BNSF Railway Company to delay the award of a Contract for a period of one hundred eighty (180) days. The undersigned agrees to hold firm on the above Bid prices and may not withdraw the Proposal for that period of time. Bidders agree that the right is reserved by BNSF Railway Company to reject any and all Bids.

4. In awarding this project, BNSF Railway Company reserves the right to choose any combination of bid items or not awarding a bid item.

5. Prices must be submitted for all individual items of this Bidding Schedule. Failure to do so may be cause for rejection of the contractor's bid.

6. BNSF Railway Company will review all submitted Pricing Schedules for any unbalancing of the items. Any submitted Pricing Schedule determined to be unbalanced may be considered not-responsive and cause the bidder to be ineligible for award.

7. APPARENT CLERCIAL MISTAKES-ARITHMETIC DISCREPANCIES
   For the purpose of initial evaluation of bids/offer, the following will be utilized in resolving arithmetic discrepancies found on the face of the Pricing Schedule as submitted by bidders/offerors:
   (1) Obviously misplaced decimal points will be corrected.
   (2) In case of discrepancy between unit price and extended price, the unit price will govern.
   (3) Apparent errors in extension of unit prices will be corrected.
   (4) Apparent errors in addition of lump-sum and extended prices will be corrected.

For the purpose of bid/offer evaluation, BNSF Railway Company will proceed on the assumption that the bidder/offeror intended the bid/offer to be evaluated on basis of the unit prices, with the total arrived at by resolution of arithmetic discrepancies as provided above and the bid/offer will so reflect the summarization of bids/offers.

8. If awarded the Contract, the undersigned hereby agrees to sign said Contract and furnish the necessary insurance certificates and bonds within ten (10) business days of the award of said Contract, and to begin Work within ten (10) business days after Notification to Proceed.

9. If requested, each Bidder must be prepared to submit, within five (5) days of BNSF's request, a notarized financial statement, financial data, and other information and references sufficiently comprehensive to permit an appraisal of the Bidder's current financial condition or ability to perform the Work.

10. All of the above statements regarding experience and financial qualifications are submitted in conjunction with the Proposal, as a part thereof, and the Bidder guarantees the truthfulness and accuracy of the information.

(Sign here if individual) (Signature) ______________________

(Printed or Typed name) ______________________

Date: ______________________

(Address)

(Sign here if Co-partnership) (Signature) ______________________

(Printed or Typed name) ______________________

Date: ______________________

(Address)

(Co-partnership name of firm) ______________________

____

(Address)

(Signature of members signing) ______________________________

____

(Address)

(Sign here if corporation) ______________________________

____

(Address)

(Signature of Officer of Corporation) ______________________________

____

(Title)

(Signature of Officer of Corporation) ______________________________

____

(Title)

(If executed by other than President, Vice-President, or Secretary of the Corporation, attach corporate minutes or resolution authorizing signature on behalf of the Corporation.

(Affix Corporate Seal here)

Contractor's License No. ______________

Telephone No. ______________

License Classification ______________

INCLUDED WITH BID SUBMITTAL

List of Sub-Contractors	Workmen's Compensation Workman's Compensation Experience Factor Rating – UBI No.
General Project Schedule (Primavera P3 compatible)	Hourly Labor Rates
Bid Schedule Information	Hourly Equipment Rates (Including vactor truck equipment rates)

Bid Schedule

Bidder shall provide a bid breakdown using the Bid Schedule form attached herewith. The Bid Schedule form consists of cost in relation to unit quantities. The Total Cost line item shall be the sum of the cost for all items. Bidder shall provide complete Bid Schedule information without modification.

The successful bidder will be required to furnish, within five calendar days of acceptance of bid, a Schedule of Values based on the Bid Schedule. All lump sum bid items are to be broken down, in detail, by components of the work or stages of construction. Materials and equipment for which partial payment is expected, when on site, are to be identified and valued in the Schedule of Values. The approved Schedule will be the basis for measuring progress for payment.

Safety Action Plan

The awarded contractor shall submit to the BNSF a Safety Action Plan for BNSF review and approval prior to initiating work on the site. This Safety Action Plan shall incorporate all related safety guidelines specific to working at BNSF facilities.

List of Subcontractors

The name and location of place of business of each Subcontractor who will perform Work or labor or render service to the General Contractor in or about the construction of the Work, or improvements in an amount in excess of one percent (1%) of the General Contractor's total bid, and the portion of the Work which is to be done by each Subcontractor is set forth as follows:

Name	Location of Business	Portion (Type of Work and % of Total Contract Amount)

____

____

____

____

____

____

Addenda
Bidder acknowledges receipt of addenda to Plans and Contract Documents listed below, if any, and agrees this Proposal is submitted on the basis of all changes in the Work specified herein and said Addenda are by this reference made a part hereof.

Addenda to Specifications Received:

<u>No.</u> <u>Date</u>

____

____

____

____

____

(Sign here if individual) ______________________________

Date: ______________________________

Address: ______________________________

____

____

BID FORM - Labor Rates

Type of Labor	Hourly Rate

(Attach Additional Sheets If Needed)

BID FORM - Equipment Rates

Equipment	Hourly Rate (including operator)

PART 4
SPECIAL PROVISIONS

PART 4

SPECIAL PROVISIONS

The special provisions of the BNSF Railway Edmonds Double Track Project shall be part of the Willow Creek project except as supplemented or revised below.

01300 Part 1.1 General Intent (Supplemented)

The work site includes layout and storage areas inside BNSF right-of-way lines between Station MT2 996+50 to Station MT2 999+30.

The work to be performed by the Contractor shall consist of, but not limited to the following work:

A. Install prestressed concrete bridge over future Willow Creek.

01500 Part 1.3 Materials Furnished By the Company (Revised)

The Company will provide the Contractor the items listed in the Bill of Materials shown on drawing BR3 in Appendix C.

01600 Part 1.9 Access Roads and Construction Roads (Supplemented)

Access to the Work Site is available from Admiral Way, Edmonds, WA.

04100 Structure Excavation and Backfill

Figure 04100-1 showing limits lines where protective shoring is required shall be replaced per the guidelines shown in the "BNSF/UP Guidelines for Temporary Shoring", October 25, 2004.

END OF SECTION

PART 5
SUPPLEMENTAL SPECIFICATIONS

SECTION 04520

BRIDGE INSTALLATION

PART 1 - GENERAL

1.1 DESCRIPTION

This work consists of installing precast concrete members, hand rails and associated bridge accessories at locations shown on the plans or as directed by the engineer, and in close conformity to the lines, grades, and dimensions shown on the plans and shall conform to the requirements herein.

1.2 RELATED SECTIONS

Coordinate related work specified in other parts of the Contract Documents and Specification including the following:

A. Section 03200 – Excavation and Embankment
B. Section 04100 – Structure Excavation and Backfill
C. Section 04200 – Piles
D. Section 04500 – Precast Concrete Construction
E. Section 04600 – Steel Construction
F. Section 04700 – Protective Coatings
D. Section 04900 – Elastomeric Bearing Pads

1.3 SUBMITTALS

A. Before beginning to erect any precast concrete members, the Contractor shall submit to the Engineer for review an erection plan and procedure per Washington State Department of Transportation Standard Specifications for Road, Bridge and Municipal Construction, 2010. Section 6-02.3(25)N and BNSF Standard Specification section 04500.

PART 2 - PRODUCTS

2.1 MATERIALS PROVIDED BY THE COMPANY

See Section 01500 for the Company provided materials.

The Contractor shall be responsible for; coordinating the delivery of materials with the Company, offloading the materials & storing the materials as required. All materials, with the exception of piling, will arrive at the project site by rail car at a time and date to be determined by the Company and coordinated with the Contractor. Piling will arrive by either rail car or freight truck at a time and date to be determined by the Company and coordinated with the Contractor.

2.2 HANDLING, STORAGE, AND SHIPPING

Handle precast members per section 04500.

2.3 ACCEPTANCE OF MATERIALS PROVIDED BY THE COMPANY

A. Acceptability of materials provided by the Company will be by the Contractor and the Company at delivery of member to the job site. The Contractor shall notify the Engineer immediately of any materials that are defective or not acceptable for use on this project.

B. Upon acceptance of the materials the Contractor shall be responsible for them. Any damage that occurs to the materials shall be repaired by the Contractor at his expense to the satisfaction of the Company.

PART 3 - EXECUTION

3.1 PREPARATION

The Contractor shall install steel piles as shown on the plans per BNSF Railway standard plans shown in Appendix B, and in accordance with section 04200.

3.2 BRIDGE INSTALLATION

Install precast concrete members and all associated bridge accessories per Section 04500 in locations shown on the plans.

3.3 COORDINATION

The Contractor shall coordinate his work based on the Company's proposed track shifting as shown in Appendix D and delivery of materials.

PART 4 - MEASUREMENT AND PAYMENT

4.1 BRIDGE INSTALLATION

A. Measurement: No specific unit of measurement will apply, but measurement will be for the sum of all items to be installed.

B. Payment: Bridge Installation will be paid lump sum which shall include all labor, materials, tools, equipment, transportation, supplies, and incidentals required to construct and install the bridge, including but not limited to precast components, handrails, deck plates, and bearing pads.

Bridge Installation shall include all labor, materials, tools and equipment necessary to offload and store materials provided by the Company excluding "CRANE MOBILIZATION FOR BRIDGE COMPONENT OFFLOADING" as specified below.

The above provision shall not be interpreted to provide payment for "Piles Driven" which shall be paid for per Section 04200.

4.2 CRANE MOBILIZATION FOR BRIDGE COMPONENT OFFLOADING

A. Measurement: Crane Mobilization for Bridge Component Offloading: Crane Mobilization for Bridge Component Offloading shall be measured per each time it is necessary to mobilize and demobilize a crane to offload the bridge components delivered to the project site via rail car.

B. Payment: Crane Mobilization for Bridge Component Offloading: The unit price for CRANE MOBILIZATION FOR BRIDGE COMPONENT OFFLOADING per each will be full compensation for all work and costs involved with mobilizing, setting up and demobilize the crane to the project site specifically for the purpose of offloading bridge components. Should the crane be used to accomplish other tasks excluding, offloading the bridge components, the mobilization shall be considered incidental to the other item of work and no payment shall be granted for "CRANE MOBILIZATION FOR BRIDGE COMPONENT OFFLOADING".

END OF SECTION

PART 6
STANDARD CONSTRUCTION SPECIFICATIONS

SECTION 04200

PILES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Piles

B. Test Piles

C. SAFETY

1. Contractor is responsible for performing all pile operations in compliance with the current state, federal, local, FRA and OSHA regulations, specifically with respect to fall protection.

(Note: See General Provisions for utility and permitting requirements and sections that apply)

1.2 DESCRIPTION

A. Piles: These specifications shall govern the furnishing, driving, building up and cutting off of timber, steel bearing, steel sheet, steel pipe, and concrete (precast and prestressed) piles in accordance with the lines, grades, and locations shown on the plans or as directed by the Engineer.

B. Test Piles

1. When shown on the plans or when directed by the Engineer, test piles shall be driven to determine the necessary lengths of piles to be ordered for the work.

2. The number and location of test piles to be driven shall be as shown on the plans or as established by the Engineer; in general, at least two test piles shall be driven at each structure.

C. Unless otherwise directed by the Engineer, the embankment at bridge ends shall be constructed to grade and thoroughly compacted to the full amount required by Section 03200, Excavation and Embankment, prior to the driving of piling in the embankment area.

Foundation piling shall not be driven until the excavation is complete.

1.3 SUBMITTALS

A. The Contractor shall provide to the Engineer a description of all pile driving equipment to be employed in the work, prior to commencement of pile installation. This shall include details including weights of pile hammer, power plant, leads, pile cushion, cap block and helmet.

B. The Contractor shall provide to the Engineer drawings demonstrating compliance of driving equipment and steel casing with Contract Documents. Drawings shall include shop and erection details, casing details, and enclosures, splices, driving helmets, and reinforcement.

C. The Contractor shall submit to the Engineer a complete report on the load test, within seven days of completion of load test, including, but not limited to, a description of the pile driving equipment, driving records for both test piles and reaction piles, complete test data, analysis of test data, and recommended allowable design loads based on the load test results. The report shall be prepared by or under the direct supervision of a registered professional or structural engineer experienced in pile load testing and load test analysis. In Addition, a "Test Pile Record Form" in accordance with Figure 04200-1 shall be submitted to the Engineer.

Figure 04200-1

BURLINGTON NORTHERN SANTA FE RAILWAY
Test Pile Record Form

BR: _________ LS: ________ TRACK: _______ PLAN NO ________________ AFE: __________ PILE TYPE: ______________________

BENT/PIER/ABUT NO.: ____ ROW NO: ____ PILE NO: ____ DATE/TIME START: ________________ DATE/TIME END: ________________

R/L IS _______ FT. ABOVE OR BELOW T/T

HAMMER MODEL: ________________________ RAM WEIGHT: ________ LBS.

DIST. T/T TO G/L: _____ FT.

CUSHION MATERIAL(S) – TYPES & THICKNESSES:
HAMMER (IF OTHER THAN MANUFACTURER'S STANDARD): ___________

TOTAL PILE LENGTH UNDER HAMMER (INCLUDE
(FOLLOWER: ________________________________FT.

CONCRETE PILE: ______________________________

DISTANCE T/ T TO P/ T AT END OF DRIVING: ______________FT.

DISTANCE T/T TO SPLICE AT END OF DRIVING: _____________FT.

R/L = REFERENCE LINE - POINT FROM WHICH PENETRATION IS RECORDED, USUALLY T/T OR G/L.

COMMENTS:

G/L = GROUNDLINE T/T = TOP OF TIE P/T = PILE TIP BPM =BLOWS PER MINUTE

R/L To P/T	# BLOWS	STROKE or BPM	R/L To P/T	# BLOWS	STROKE or BPM	R/L To P/T	# BLOWS	STROKE or BPM	R/L To P/T	# BLOWS	STROKE or BPM	R/L To P/T	# BLOWS	STROKE or BPM

Foreman/Inspector: ______________________ Page __ of __

Test Pile Record Form 12-00.doc

D. The Contractor shall submit to the Engineer a complete and accurate record of each driven pile, within 3 days of completion of driving. The record shall indicate the pile location, driven length, embedded length, final elevations of tip and top, pile weight, butt and tip diameter, quantity and strength of concrete used in each pile, number of splices and locations, blows required for each foot of penetration throughout the entire length of the pile and for the final 6 inches of penetration, and the total driving time. The record shall also include the type and size of the hammer used, the rate of operation, and the type and dimensions of driving helmet, pile cushion, and cap block used. Any unusual conditions encountered during pile installation shall be recorded and immediately reported to the Engineer. In Addition, a "pile Driving Summary Form" in accordance with Figure 04200-2 shall be submitted to the Engineer.

Pile Drive Summary Form

Br: ______ LS: _____ Track: _____ Plan No: _____________ AFE: _______ Pile Type: ______________________

Hammer Make & Model: ______________ Ram Weight:________ * Last Foot for friction pile, last inch for bearing on rock.

Determine Bent No., Pier No. and Row No., and Pile No. using the "Structures Diagrams" in the SIR Reference Menu.

G/L = Groundline T/T = Top of Tie BPM = Hammer Blows per Minute Ru = Ultimate Resistance

Date	Bent No. or Pier No. &	Pile No.	Length of Pile (Ft.)		Last Foot (or Inch) of Penetration *				Remarks
			Penetration (GL to Tip)	T/T To G/L	Stroke Or BPM	No. Blows	Resistance Ru (Tons)	Required Ru (Tons)	

Foreman/Inspector: ______________________________ Page ___ of ___ Pile Driving Summary Form 12-00.doc

PART 2 MATERIALS

2.1 TIMBER PILES

A. Timber piles shall be in accordance with Chapter 7, Part 1, Article 1.9 of the AREMA Manual for Railway Engineering for first-class piles with a minimum tip circumference of 25 inches.

B. If preservative treatment is specified in the special provisions or on the plans, it shall be in accordance with Chapter 3, Part 6 of the AREMA Manual for Railway Engineering.

C. The method of storing and handling timber piles shall be such as to avoid damage to the piles. Piles shall be handled with hemp or synthetic fiber slings or wire rope encased in rubber hose whenever possible, taking care to avoid dropping, bruising, breaking or penetrating the outer fibers.

2.2 STEEL PILES

A. Steel Bearing Piles: Steel bearing piles shall be of the section shown on the plans and shall be structural steel, containing no less than 0.2% copper, conforming to ASTM Designation: A 36. Piles shall not be painted before driving.

B. Steel Sheet Piles: Steel sheet piles shall be of the section and length shown on the plans and shall conform to ASTM Designation: A 328 unless otherwise shown on the plans.

C. Steel Pipe Piles:

1. Steel pipe piles shall be of the outside diameter and wall thickness shown on the plans and shall conform to ASTM Designation: A 252, Grade 2 unless other material is specified on the plans. Piles shall have a 3/4 inch thick steel (ASTM Designation: A 36) closure plate of the same outside diameter as the pile groove welded to the pile on the tip end. Piles shall not be painted before driving.

2. All concrete materials and reinforcing steel and their preparation and placement, used in filling steel pipe piles, shall be in accordance with Section 04400, Concrete Construction. All concrete shall have a minimum compressive strength equal to that shown on the plans.

D. Reinforced Pile Tips: If shown on the plans or directed by the Engineer, steel bearing piles shall be equipped with a cast steel reinforced driving tip in accordance with details shown on the plans. The tips shall be installed in accordance with the manufacturer's recommendations.

E. Storing and Handling: Piles to be stored shall be placed on skids above ground and a sufficient number used to prevent visible deflection in the stored piles. Piles shall be kept clean and fully drained at all times. The method of handling shall be such that no damage will result to the piles.

2.3 CONCRETE PILES

A. Precast

1. Precast concrete piles shall be of the type, size and length shown on the plans.

2. All concrete materials and steel reinforcing and their preparation and placement shall be in accordance with Section 04500, Precast Concrete Construction. All concrete shall have a minimum compressive strength equal to that shown on the plans.

B. Prestressed: Prestressed concrete piles shall meet the requirements, and shall be of the type, size, and length shown on the plans, manufactured in accordance with Section 04500, Precast Concrete Construction.

C. Defects and Breakage: Piles cracked in the process of curing, handling or driving, which in the opinion of the Engineer can be satisfactorily repaired, shall be repaired at the Contractor's expense and under the direction of the Engineer. If repair is not possible in the opinion of the Engineer, the piles shall be replaced at the Contractor's expense.

D. Storing and Handling

1. The method of storing and handling piles shall be such as to minimize the danger of fracture by impact or undue bending stresses. Unless otherwise provided, piles shall be handled by means of a suitable bridle or sling attached to the pile at the pick-up points marked on the pile. Use of rubberized cables is also acceptable. The use of chain slings will not be permitted.

2. Piles shall be stored above ground on adequate blocking located within 1 foot of the pick-up points marked on the pile that will prevent undue stresses in the piles. When piles are only partially supported during hauling, the overhang shall not exceed the lengths permitted for pick-up. If piles are stacked for storage, blocking for all layers shall be in the same vertical plane.

PART 3 EXECUTION

3.1 DRIVING PILES

A. Driving Equipment

1. Piles shall be driven with steam, air, or diesel powered hammers approved by the Engineer prior to use. The use of drop hammers will not be permitted. The weight of the ram of the hammer shall not exceed 7000 lb. unless approved in writing by the engineer. The hammer to be used shall have the approval of the Engineer. Steel sheet piles and steel H piles may be driven with vibratory hammers under conditions approved by the Engineer.

2. The minimum acceptable hammer energy for use with various pile types is as follows:

Pile Type	Minimum Energy (ft-lbs)
Timber, less than 60 ft long	8,000
Timber, more than 60 ft long	13,000
Steel Bearing and Steel Pipe	30,000
Concrete	15,000 (but not less than 1.5 ft-lb per pound of pile).
Steel Sheet	As necessary to drive the piles to the required depth without damage to the piles.

3. The hammer shall be operated at all times at pressures and speeds recommended by the manufacturer. If steam or air hammers are used, boiler or air compressor capacity shall be adequate to maintain full rated pressure throughout the driving period of any pile. The boiler or air compressor shall be equipped with an accurate pressure gage at all times.

4. Pile drivers shall be equipped with leads which are constructed in such a manner as to afford freedom of movement of the hammer and to provide adequate support of the pile during driving. The longitudinal axis of the leads and hammer shall coincide with the longitudinal axis of the pile. Except where piles are driven through water, the leads shall be long enough so that a follower will not be necessary. Where a follower is required for driving piles underwater, one pile in each group of ten shall be long enough to permit driving without a follower. This pile shall be used as a test pile for proper correlation of the follower-driven piles bearing capacity. This pile shall be paid for as a permanent pile and not as a "test pile."

B. Driving Tolerances

1. Piles for bent construction shall be driven with a degree of accuracy that will permit framing into bents with a minimum of pulling or jacking. Under ordinary conditions, timber piles, after driving and before framing, shall not vary from the vertical or from the required batter by more than 1/4 inch per foot of pile above finished ground. Other types of piles, after driving and before framing, shall not vary from the vertical or from the required batter by more than 1/8 inch per foot of pile above finished ground, except that under ordinary conditions, the maximum deviation of the top of the pile from the plan location shall be 2 inches in the direction of the structure centerline and 4 inches in the direction along the centerline of the bent.

2. Foundation piles shall be driven to the vertical or batter line shown on the plans and the top of the completed pile shall not be more than 4 inches in any direction from the position shown on the plans. The center of gravity of the completed pile group shall not vary by more than 3 inches from the center of gravity determined from plan location.

3. If necessary to meet the required tolerances, pilot holes or guide templates may be used. Generally, the diameter of pilot hole shall be as specified in Paragraph 3.1.F.1.

C. Protection of Pile Heads

1. A steel driving head suitable for the type and size of piles being driven shall be used. Steel bearing piles and steel sheet piles shall be driven with a driving head compatible with the specific pile shape driven.

2. For concrete piles, a cushion block shall be provided between the driving head and the top of the pile. Wood cushion blocks, wire rope mat, belting, or other suitable material shall be used, subject to the approval of the Engineer, to prevent damage to the pile. Cushion blocks shall be changed as necessary to maintain an effective cushion.

D. Pile Damage and Misalignment: Care shall be exercised to avoid damage to piles from overdriving. Any pile that is damaged to the extent that, in the opinion of the Engineer, it will not perform its design function; any pile that is driven off location or alignment beyond the allowable tolerances; or any timber pile that is driven below cut-off elevation shall be pulled, if possible, or cut off below ground line and another pile driven as close as possible to the proper location. Splicing of timber piles will not be permitted. If the defective pile condition is due to Contractor's negligence, the cost of replacement and redriving shall be borne by the Contractor.

E. Pile Penetration

1. All piles shall be driven to a penetration satisfactory to the Engineer. The length of the piles shown on the plans is the length which is estimated to give the minimum required penetration and bearing, and is for estimating purposes only.

2. When test piles are required by the contract, the pile lengths and penetration required will be established by the Engineer on the basis of the test pile data. These lengths and elevation of pile tips shall supersede requirements shown on the plans.

3. Unless otherwise shown on the plans or directed in writing by the Engineer for cases where piles penetrate into competent rock, foundation piles shall be driven to a penetration of a minimum 10 feet below bottom of footing, and other piles to a penetration of at least 15 feet below natural or finished ground line, whichever is lower. Piles in streambeds or on the banks of streams, where marked erosion is expected, shall be driven to such penetration as the Engineer deems necessary for protection against scour.

4. When the specified penetration cannot be obtained without overdriving the piles, the Contractor shall provide either pilot holes or jetting equipment or a combination of both, as directed by the Engineer.

F. Pilot Holes

1. If piles cannot be driven to the required penetration and the material is not suitable for jetting, the Engineer may permit pilot holes to be drilled to facilitate driving. The Engineer will designate the diameter and depth of the drilled hole. Ordinarily, a drill diameter of 12 inches will be satisfactory for timber piles and typically a drill diameter 4 inches less than the diagonal of square piles, 2 inches less than the diagonal of octagonal piles, and 1 inch less than the diameter of round piles will be satisfactory for steel pipe and concrete piles.

2. Where pilot holes are required in granular material which cannot be sealed off by ordinary "mudding" drilling methods, a casing pipe of sufficient diameter shall be placed around the boring device. The casing shall be of sufficient length to extend through the loose materials and shall be held in position until the pilot hole is completed and the pile placed ready for driving.

3. If the hard material extends below the desired penetration, the drilling shall be stopped 1 foot above that level and the pile driven the remaining distance if it is possible to do so without damaging the pile. If the pile does not completely fill the pilot hole, the space between the pile and the wall of the hole shall be filled with dry granular material prior to driving as directed by the Engineer.

4. Pilot holes shall be considered as incidental to piles and no direct payment will be made for this work.

G. Jetting

1. For jetting operations sufficient power shall be provided, in addition to that used for operating the hammer, to supply water volume and pressure sufficient to freely erode the material adjacent to the pile.

2. Jetting shall be stopped a minimum of 2 feet above the desired tip elevation and the final penetration obtained by driving without jetting. In silty soils it is possible that jetting may loosen the soil around piles already driven. If such a condition is considered possible, piles shall be redriven after all jetting within 25 feet has been completed.

3. Jetting shall be considered as incidental to piles, and no direct payment will be made for this work.

H. Shooting Pilot Holes: The use of explosives for drilling of pilot holes will not be permitted.

I. Bearing Capacity

1. All piles shall be driven to the ultimate bearing capacity specified on the plans, in the special provisions, or by the Engineer. The bearing values shall be determined

using the wave equation method or the following formula as directed by the Engineer:

$$Ru = \frac{12eE}{s + c} \times \frac{W + n^2P}{W + P}$$

Ru = Ultimate dynamic pile resistance (pounds)
e = Hammer efficiency = 0.9
E = Hammer energy per blow = Wh for single acting steam or air hammer or open cylinder Diesel hammer.
s = Penetration of pile per hammer blow (inches)
c = Average temporary compression (inches). The value of c shall be determined from test pile rebound graphs or as specified by the Engineer.
W = Weight of striking parts of hammer (pounds)
h = Hammer ram stroke (feet) average during 1 inch of pile penetration
n = Coefficient of restitution = 0.7
P = Weight being driven (pounds) includes pile and pile follower, anvil, drive cap and adapter as applicable

2. When measuring penetration per blow to determine if adequate bearing capacity has been obtained, the hammer shall be running freely and at the speed specified by the manufacturer for full rated energy output.

3. If, for some unavoidable reason, driving must be interrupted before final penetration is reached, the penetration per blow to determine bearing capacity shall not be measured until 12 inches of penetration or refusal has been obtained after driving has been resumed.

J. PILE DRIVING NEAR FRESH CONCRETE

1. Piles shall not be driven within 150 feet of concrete that was placed within the previous 24 hours. If piling are driven within 150 feet of concrete that has not attained its specified 28-day strength, the following distances, based on the concrete strength and pile hammer rated energy, shall be maintained between the concrete and the nearest pile.

Distance to Concrete

Percent of 28 Day Strength	Energy less than 40,000 ft-lb	Energy 40,000 ft-lb to 60,000 ft-lb	Energy 60,000 ft-lb or greater
20	60 feet	70 feet	85 feet
40	35 feet	45 feet	50 feet
60	25 feet	25 feet	30 feet
80	10 feet	15 feet	15 feet

3.2 TEST PILES

A. The furnished length of test piles shall be a minimum of 10 feet longer than the estimated length of the permanent piles shown on the plans or as directed by the Engineer.

B. Wherever possible, test piles shall be driven in a location such that they can become part of the permanent structure. If not so used, test piles shall be cut off or extracted as directed by the Engineer. Extraction of test piles shall be considered incidental to the test pile item, and no separate compensation will be made for this work.

C. Ground elevations shall be brought to finished grade wherever possible prior to driving test piles, so that the test pile will be comparable to the piles used in the permanent structure.

D. Equipment used for driving test piles shall be adequate for handling the lengths provided without splicing. The hammer used shall be the same make and model as that to be used in driving the permanent piles.

E. Driving of a test pile shall continue until a penetration and bearing capacity is obtained which is satisfactory to the Engineer. Typically, test piles shall be driven to not less than 125% of the ultimate pile capacity required for permanent piles in the bridge structure.

3.3 TIMBER PILES

A. Pile Preparation

1. When the furnished length is much longer than the required length, the Engineer may permit shortening the tip end before driving so as to have the desired diameter at the cut-off.

2. Pile tips shall be cut perpendicular to the axis of the pile.

3. The piles for bents shall be matched as much as possible in diameter to facilitate framing and bracing.

B. Cut-offs

1. Piles which are to be encased in concrete shall be cut-off square with a saw to the elevation shown on the plan or established by the Engineer. The pile heads shall then be swabbed with preservative as specified on the plans.

2. Piles which are to support steel or timber caps shall be brought into final position and held while cut-off is made. Any chains or jacks used in positioning the piles shall be arranged so that the surface of the pile below cut-off will not be damaged. Cut-off shall be made with a saw to a true plane and to the exact elevation shown on the plans or established by the Engineer so that the cap will bear on the entire cross section of each pile in the bent. No shims will be permitted between the pile and the cap. Piles must show a solid head at the plane of cutting, and after cut-off, the pile caps shall be protected with preservative, fabric, and plastic cement as specified on the plans.

3. Cut-off portions of piles furnished by the Company remain the property of the Company, and shall be hauled to and loaded into rail cars by the Contractor. In the event rail cars are not available, the cut-offs will be stockpiled at a location designated by the Engineer. Stubs under 5 feet in length shall be disposed of by the Contractor in accordance with all applicable environmental laws and regulations. No extra payment will be allowed for this work.

C. Treatment of Damaged Surfaces: Any pile surface below cut-off that has been scuffed, torn or otherwise damaged shall be treated in accordance with the requirements of the applicable plans.

3.4 STEEL BEARING PILES AND STEEL SHEET PILES

A. Splices and Build-ups: The length of steel bearing piles and steel sheet piles shown on the plans or ordered by the Engineer may be built up in sections either before or during driving operations. The sections, unless otherwise shown on the plans, shall be of identical cross-section. Pile splices shall be made by full penetration butt welding the entire cross-section or as otherwise shown on the plans. All welding shall be in accordance with ANSI/AASHTO/AWS D1.5 Bridge Welding Code. Care shall be taken to properly align the sections connected so that the axis of the pile will be straight. Pile splices above a point 15 feet below finished ground line shall be reinforced as shown on the plans, unless otherwise directed by the Engineer. Field splices shall be avoided for lengths under 60 feet.

B. Cut-Offs: Piles shall be cut off, with a cutting torch, or by other acceptable methods, to the elevation shown on the plans or established by the Engineer. Where caps are required, piles shall be brought into final position and held while cut off is made and the end surface of the piles shall be made as smooth as practicable with maximum gap of 1/8 inch between pile and pile cap.

3.5 STEEL PIPE PILES

A. Splices and Build-ups

1. The length of a steel pipe pile may be built up in sections either before or during the driving operation. The minimum length of a section measured between welded splices shall be 5 feet, and between drive splices shall be 30 feet. Only one welded splice and no drive splices will be permitted in that portion of the pile exposed above ground line or normal water line. Drive splices shall be 15 feet below the ground line, unless directed by the engineer.

2. Care shall be taken to properly align the sections to be spliced to insure a straight axis. The sections shall be spliced together in accordance with details shown on the plans. All welding shall be in accordance with the ANSI/AASHTO/AWS D1.5 Bridge Welding Code.

B. Cut-Offs: Piles shall be cut off, with a cutting torch, or by other acceptable methods, to the elevation shown on the plans or established by the Engineer. Where caps are required, piles shall be brought into final position and held while cut off is made and the end surface of the piles shall be made as smooth as practicable with maximum gap of 1/8 inch between pile and pile cap.

C. Placement of Concrete

1. After all driving, splicing, and positioning of pile is completed, the pile shall be free from buckles, splits, distortions, water or other foreign matter. The Contractor shall provide equipment, lighting, and facilities necessary for the proper inspection of the piles. Any damaged, improperly driven, or otherwise defective pile shall be removed and replaced at the Contractor's expense.

2. The tops of piles shall be kept covered after driving until the concrete is placed. No concrete shall be placed in the piles in any unit until the driving of all piles in that unit has been completed. No concrete shall be placed until the Engineer has inspected the completed pile and reinforcing steel, when required, and given his approval to proceed. Unit is defined as a pier, bent or abutment.

3. Concrete shall be placed in a continuous operation taking care to prevent segregation. Special placing devices shall be used if necessary.

3.6 PRECAST AND PRESTRESSED CONCRETE PILES

A. Build-ups

1. Build-ups shall be made in accordance with the details shown on the plans or provided by the Engineer. The concrete used for the build-up shall be of the same quality as that used originally in the pile. Just prior to placing the concrete, the top of the pile shall be coated with an epoxy bonding compound approved by the

Engineer.

2. When additional driving of precast non-prestressed piles is required, the built-up portion shall obtain a compressive strength equal to the design compressive strength of the original pile prior to redriving.

B. Cut-Offs: Concrete at the end of a pile terminating in cast-in-place concrete shall be cut back the required amount leaving the reinforcing steel or prestressing steel exposed. The final cut of the concrete shall be normal to the axis of the pile. Any damage to the pile below the plan cut-off elevation shall be remedied by further cut-back and built-up.

PART 4 MEASUREMENT AND PAYMENT

4.1 MEASUREMENT OF PILES

A. General

1. Piles delivered of the various kinds, sizes, types, and weights will be measured by the lineal foot, except steel sheet piles will be measured by the square foot, of acceptable pile delivered at the site of work and furnished in accordance with the lengths specified on the plans.

2. Piles driven of the various kinds, sizes, types, and weights will be measured to the nearest 1/10 lineal foot of net length of pile in place, except steel sheet piles will be measured by the square foot of acceptable pile in place, after all cut-offs and build-ups have been made.

3. That portion of piles driven below the elevation required by the plans or as directed by the Engineer and piles driven below the elevation at which the minimum penetration and bearing requirements were first obtained will not be measured for payment.

B. Timber Piles

1. Piles supplied by the Company which fail during driving, due to an inherent weakness in the pile and not due to negligence on the part of the Contractor, and which are extracted or cut-off at the direction of the Engineer, will be measured for payment by the lineal foot of pile in the leads. Piles supplied by the Company and broken during driving due to Contractor's negligence will not be measured for payment. Piles supplied by the Contractor and broken during driving will not be measured for payment.

2. Cut-off portions of piles will not be measured for payment.

C. Steel Piles: Cut-off portions of piles will not be measured for payment.

D. Concrete Piles, Precast and Prestressed

1. Two feet will be added to the length of piles, measured for payment in accordance with Paragraph 4.1.A.1, for each authorized build-up made, other than those made necessary by improper casting, handling or driving of piles.

2. Cut-off portions of piles, when piles are supplied by the Contractor in the lengths shown on the plans or ordered by the Engineer, will be measured by the lineal foot of cut-off above design elevation. Cutbacks made below design elevation for the purpose of making build-ups will be considered incidental to the work and will not be measured.

3. When piles of extra length are furnished to eliminate protrusion of reinforcing steel required for splicing, such extra length will not be measured for payment as either piles or cut-off portion of piles.

4.2 PAYMENT FOR PILES

A. Piles Delivered: Piles delivered shall be paid for at the contract unit price per lineal foot or square foot, as designated in Paragraph 4.1, of the various kinds, sizes, types, and weights. This price shall include full compensation for all work and costs involved for furnishing the piles, unless otherwise specified; unloading, storing, and transporting the piles. This price shall not include compensation for concrete or reinforcing steel in steel pipe piles which will be paid for under Section 04400, Concrete Construction.

B. Piles Driven: Piles driven shall be paid for at the contract unit price per lineal foot or square foot, as designated in Paragraph 4.1, of the various kinds, sizes, types, and weights. This price shall include full compensation for furnishing all labor, materials, tools, equipment, jetting, pilot holes, and incidentals necessary to drive and cut-off the piles and complete the work. The Contractor shall accept the contingencies of driving greater or lesser length of piles or other changes of features in construction which this may involve, all without modification of the unit price fixed by the contract.

C. Timber Piles: The contract price per lineal foot of acceptable timber pile shall also include full compensation for preparing the piles, disposing of the pile heads, treating the pile tops as specified in Paragraph 3.3.B. and the treating of damaged surfaces, splits, and checks as specified in Paragraph 3.3.C.

D. Steel Bearing Piles and Steel Pipe Piles: Payment for the work and materials, exclusive of additional length of pile, required in making each pile splice shall be made at a unit price per splice equal to two times the unit price bid for "Steel Bearing Piles Driven" or "Steel Pipe Piles Driven," as applies, of the size and weight on which the splice is made except that no payment will be made for any splice on any pile whose actual length left in place, after all cut-offs, splices, or build-ups have been made, is not greater than the length shown on the plans or specified by the Engineer, nor will payment be made for more than one splice on any one pile less than 120 feet long.

E. Steel Sheet Piles: No direct payment will be made for cut-off portions of piles.

F. Concrete Piles, Precast and Prestressed: Cut-off portions of piles, measured in accordance with Paragraph 4.1.D.2, will be paid for at one half the unit price bid per lineal foot for concrete piles.

4.3 MEASUREMENT OF TEST PILES

A. Test piles of the various kinds, sizes, types and weights, when the piles do not become a part of the permanent structure, will be measured by the lineal foot of pile in the leads and driven in accordance with these specifications and in the location specified on the plans or by the Engineer. When test piles becomes a part of the permanent structure, they will be measured by the lineal foot of acceptable pile in place after all cut-offs and build-ups have been made in accordance with the provisions of Paragraph 4.1 covering the various kinds of piles.

4.4 PAYMENT FOR TEST PILES

A. Test piles shall be paid for at the contract unit price per lineal foot of test pile of the various kinds, sizes, types, and weights. This price shall include full compensation for furnishing the piles, unless otherwise specified; unloading, storing, and transporting the piles; and for furnishing all labor, materials, tools, equipment, jetting, pilot holes, and incidentals necessary to drive the piles and complete the work. Payment will be made for splices authorized by the Engineer at the rate specified in Paragraph 4.2.C.

4.5 MEASUREMENT FOR REINFORCED PILE TIPS

A. Reinforced pile tips will be measured by the number of reinforced tips installed on steel bearing piles and driven in place.

4.6 PAYMENT FOR REINFORCED PILE TIPS

A. Payment for reinforced pile tips on steel bearing piles, if required, shall be made at the contract unit price per each which shall be full compensation for furnishing all material, labor and equipment required to install the tips. Payment will be made only for reinforced tips required as shown on the plans or as requested by the Engineer.

END OF SECTION

SECTION 04600

STEEL CONSTRUCTION

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Steel Construction

B. SAFETY

1. Contractor is responsible for performing all steel construction operations in compliance with the current state, local, federal, FRA and OSHA regulations, paying special attention to the fall protection.

1.2 DESCRIPTION

A. These specifications shall govern the furnishing, fabricating, and erecting of steel structures including the furnishing, erecting and removal of falsework and special erecting devices, as required, and structural steel portions of other structures in accordance with these specifications, the special provisions, and the details shown on the plans.

1.3 SUBMITTALS

A. The Contractor shall submit drawings and design calculations showing the proposed design, method of construction and removal of falsework and special erecting devices, as required. These drawings and design computations, stamped by a licensed professional structural engineer in the state where the work is to be done, shall be submitted to the Engineer and approved prior to the start of construction. This approval shall not relieve the Contractor of responsibility for the falsework or special erecting devices.

PART 2 MATERIALS

2.1 STRUCTURAL STEEL

A. All design, material erection and its fabrication shall be in accordance with Chapter 15, Parts 1 and 3, of the AREMA Manual for Railway Engineering and as specified in the special provisions or on the plans.

B. Steel construction shall be cleaned and painted or galvanized, as applicable, in accordance with Section 04700. Protective Coatings for Steel Surfaces.

2.2 STRUCTURAL BOLTING

A. Bolts and nuts shall be furnished by the same supplier to ensure proper fit.

B. Rotational-capacity tests shall be performed on all black or galvanized bolt, nut and washer assemblies by the manufacturer or distributor prior to shipping. Each combination of bolt production lot, nut lot and washer lot shall be tested as an assembly and a rotational-capacity lot number assigned to each combination of the lots tested. The manufacturer or distributor shall furnish, to the Engineer, a manufacturer's certified test report (MCTR) or a distributor's certified test report (DCTR) for each rotational-capacity lot furnished. The MCTR or DCTR shall include the results of all tests; location of where bolt assembly components were manufactured; the date and location of the tests; results of the R-C tests and a statement that the materials represented by the test report conform to the specifications.

C. Bolts shall be of such length that they will extend entirely through their nuts and approximately 1/4 inch beyond them and the full threads shall extend no more than 3/8 inch into the grip.

2.3 FALSEWORK

A. Falsework materials shall be in accordance with the Contractor's drawings, when applicable, and approved by the Engineer.

2.4 LIQUID TYPE EPOXY

A. The liquid type epoxy shall be a two component, epoxy-resin bonding system conforming to the requirements of ASTM Designation: C 881, Type IV, Grade 2, Class B or C. The class supplied shall be governed by the range of temperatures for which the materials is to be used.

2.5 HANDLING AND STORING MATERIALS

A. All material shall be handled in a manner which will prevent members from being distorted or damaged. Stored material shall be piled securely, and no material shall be placed closer than 25 feet to the centerline of the nearest tracks. Material shall be placed on level platforms, skids, or other supports above the ground and shall be kept clean and properly drained. Girders and beams shall be placed upright and shored. Long members, such as columns and chords, shall be supported on skids placed near enough together to prevent damage from deflection.

B. For those members designated as fracture critical members (FCMs); the following shall apply: extraordinary care shall be taken in the handling of FCMs. Lifting dogs, tongs, grips, chains, cables, or other lifting devices placed in direct contact with the FCM which may gouge, scratch, score, scrape, or otherwise damage the surface, edges or corners of FCMs shall not be used. Procedures for handling FCMs using lifting straps, timber cushions or other protective devices shall be developed, submitted to the Engineer, and receive written approval by the Engineer before handling any material for or members designated as FCM.

C. All materials shall be carefully loaded so as to avoid injury in transit. Members weighing more than 3 tons shall have the weight marked thereon. All small parts such as rivets, bolts, pins, washers, and small connection plates shall be packed in containers, of adequate strength. The contents of each unit shall be plainly marked on the top of each container.

D. Girders shall be shipped in an upright position and adequately blocked and braced to prevent damage during shipping. The Fabricator shall submit girder loading diagrams to the Engineer for approval well in advance of the anticipated shipping date. These diagrams shall include proposed blocking, bracing and tie-down details.

PART 3 EXECUTION

3.1 ERECTION

A. Methods and Equipment:

1. Before staring work, the Contractor shall advise the Engineer fully as to the method he proposes to follow, and the amount and character of equipment he proposes to use, which shall be subject to the approval of the Engineer. The approval of the Engineer shall not be considered as relieving the Contractor of the responsibility for the safety of his method or equipment or from carrying out the work in full accordance with the plans, specifications and special provisions.

2. No field welding or flame cutting will be allowed on the steel spans unless shown on the plans or authorized in writing by the Engineer. Tack welding, for the purpose of eliminating field erection bolts or for holding steel parts together while bolting, will not be permitted.

3. The Contractor shall provide the falsework, special erecting devices and all tools, machinery and appliances, including drift pins and erection bolts, necessary for the expeditious handling of the work. Drift pins sufficient to fill at least 1/4 of the bolt holes for main field connections shall be provided.

4. All steel beams or girders placed shall be securely tied and/or braced to prevent overturning immediately after erection, and until diaphragms, floor beams or cross frames are permanently in place. The methods to be used shall be submitted on the erection drawings. When railroad or roadway traffic must be maintained beneath girders or beams already placed, traffic shall be protected against falling objects during the erection of diaphragms and other structural members, during the placing of cast-in-place concrete and during the erection and dismantling of

forms. The protection shall consist of nets and/or flooring with no larger than 1-inch openings.

B. Falsework:

1. The falsework shall be constructed in accordance with the Contractor's plans, approved by the Engineer, and shall be properly maintained.

2. Equipment for removing falsework shall not be operated upon or attached to any portion of the new structure.

C. Assembling Steel:

1. All parts shall be accurately assembled as shown on the plans and any match marks carefully followed. The material shall be carefully handled so that no parts will be bent, broken or otherwise damaged. Hammering which will injure or distort the members will not be permitted. Drifting done during erection shall be only such as required to bring the parts into position and enlarging the holes or distorting the metal will not be permitted.

2. Bearing surfaces shall be cleaned of all dirt, loose rust and mill scale, grease, and paint just before the members are assembled. Wire brushes, scalers, solvents or flame shall be used to clean the surfaces under the direction of the Engineer.

3. Fitting up bolts shall be 1/16 inch less in diameter than the hole, and cylindrical erection pins shall be 1/32 inch less in diameter than the hole.

4. Unless erected by the cantilever method, truss spans shall be erected on blocking so placed as to give the trusses proper camber until all lower chord splices are fully connected, as called for on the plans, and all other connections are made with pins and fitting up bolts. Trusses erected by the cantilever method shall have all lower chord splices fully connected before the span is swung on intermediate falsework or permanent shoes. If necessary, such as in the case of high falsework subject to settlement, jacks shall be provided under panel points to enable making necessary adjustments to facilitate fitting up without heavy drifting. Splices of butt joints in compression members shall not be fully connected until the span has been swung. Full bearing shall be secured on milled surfaces that are designed to bear.

5. Sole plates on beams and girders shall be in full contact with bearings before diaphragm, cross frame, or floor beam connections are made. Connections shall be adjusted as necessary, under the direction of the Engineer, to obtain full contact.

6. Bridge handrails shall be erected plumb and in line in accordance with the drawings. Maximum vertical tolerance is +/- ¼ inch from plumb line over the full vertical height. Maximum horizontal tolerance is +/- ½ inch over the full length of the bridge rail.

D. Misfits and Straightening of Bent Material:

1. The correction of minor misfits involving harmless amounts of reaming, cutting, and chipping and the straightening of minor cases of bent bars, plates, and the outstanding legs of angles, etc., shall be considered a legitimate part of the erection and shall be done by the Contractor at his expense. However, any error in the shop fabrication, or deformation resulting from handling and transportation which prevents the proper assembling and fitting up of parts by the moderate use of drift pins, or by a moderate amount of reaming, slight chipping or cutting, shall be reported immediately to the Engineer who will specify the method of correction to be used by the Contractor. The correction shall be made in the Engineer's presence.

2. The straightening of bent materials, when permitted by the Engineer, shall be done by methods that will not produce fracture or other injury. Distorted members shall be straightened by mechanical means or, if approved by the Engineer, by the carefully planned and supervised application of a limited amount of localized heat. The temperature of the heated area shall not exceed 1200 degree F (a dull red which may not be visible in bright sunlight) as controlled by temperature indicating crayons, liquids or bimetal thermometers. Parts to be heat straightened shall be substantially free of stress and from external forces, except stresses resulting from mechanical means used in conjunction with the application of heat. After heating and straightening, the metal shall be cooled as slowly as possible. Following the straightening of a bend or buckle, the surface of the metal shall be carefully inspected for evidence of fracture.

3. When, in the opinion of the Engineer, excessive misfits and deformed material are not due to the Contractor's negligence, the correction of the misfits and straightening of the deformed material shall be done by the Contractor, when directed by the Engineer, and will be paid for by the Company as "Force Account Work," providing the material was furnished by the Company.

E. Bearings and Anchorage:

1. Bearings shall be set level in exact position and shall have full and even bearing upon the bridge seat areas. All bearings shall be set so as to be at the proper location at a temperature of 60 degree F under full dead load. At this temperature, rockers shall be vertical, bearings shall be centered under the structure center line of bearing, and sliding plates shall be centered on the bearing plates.

2. The area of concrete under bearings shall be bush-hammered if necessary to provide a full and even bearing at the correct elevation. When the bridge seat is more than 1/8 inch below plan elevation, the bearings shall be raised to grade on steel plate of the same size as the bearing. The plates shall be provided by the Contractor at his expense and attached to the bearings in a manner satisfactory to

the Engineer.

3. Portland cement in a stiff paste form shall be spread over the bush-hammered areas just before the bearings are set. The maximum amount of cement which will be permitted will be no more than necessary to remove irregularities in the concrete with no intent of raising the bearings.

4. Finished surfaces of bearings in moving contact shall be cleaned and greased when the bearings are placed.

5. Holes for anchor bolts shall be drilled in the bridge seat in exact locations. Holes shall be approximately 1/4 inch larger in diameter than the bolt. An approved liquid type epoxy supplied by the Contractor at his expense shall be used to set the anchor bolts. Before placing the bolts, the holes shall be cleaned of all dust and loose material by flushing with water, after which holes shall be blown dry. After all steel is in place and the bearings are set, the anchor bolts shall be set accurately with sufficient epoxy placed in the bottom of the holes so that after a bolt is inserted, the hole will be completely filled. The bolts shall not be disturbed in any way for at least 24 hours, or until the epoxy is set. Mixing and use of epoxy shall be as recommended by the manufacturer of the epoxy.

F. Pin Connections: All packing washers, if any, must be in place when the work is assembled. While pins are being driven into place, threads shall be protected by pilot and driving nuts supplied by the Contractor. After nuts are tightened, the threads adjacent to the nut shall be burred a minimum of two threads at two locations opposite of each other.

G. High Strength Bolted Connections:

1. Connected Material:
    a. Connections shall be accurately fitted up before high strength bolts are placed. A sufficient number of the holes at a connection point shall be filled with erection pins to "fair-up" all holes. Light drifting will be permitted, but drifting to match unfair holes will not be permitted. Such holes shall be reamed or drilled under the direction of the Engineer.
    b. All material within the grip of the bolt shall be steel. There shall be no compressible material such as gaskets or insulation within the grip.
    c. Unless otherwise indicated on the plans, bolts oriented vertically shall be installed with the heads on top of the connected pieces.

2. Surface Conditions:
   a. All joint surfaces, including those adjacent to the bolt heads, nuts or washers, shall be free of dirt, loose rust, loose scale, burrs and other matter that will prevent solid seating of the parts.
   b. Unless otherwise shown on the plans, faying surfaces of all nongalvanized joints, including splice plates, shall be given a blast cleaning, in accordance with the requirements of the Steel Structures Painting Council Specifications SSPC-SP7 Brush-Off Blast Cleaning, and shall be free of loose rust prior to final bolting.
   c. Galvanized faying surfaces shall be roughened by hand wire brushing prior to final bolting.
   d. When shown on the plans, faying surfaces shall be blast cleaned and coated with a paint that provides the specified mean slip coefficient as determined by the "Test Method to Determine the Slip Coefficient for Coatings Used in Bolted Joints" as adopted by the Research Council on Structural Connections. Coated joints shall not be assembled before the coating has cured for the minimum time used in the qualifying test.

3. Handling and Storage of Fasteners: Bolts and nuts shall be protected from dirt and moisture at the job site. Only as many fasteners as are anticipated to be installed and tightened during a work day shall be taken from protected storage. Fasteners not used shall be returned to protected storage at the end of the day. Fasteners shall not be cleaned of lubricant that is present in the as-delivered condition. Fasteners that show signs of rust or dirt shall be cleaned and relubricated prior to installation. Any additional lubrication required must be applied prior to installing bolts in the holes. ASTM Designation: A 325 or A 490 bolts and associated nuts and washers shall be identified by rotational-capacity lot number and stored in a manner that will retain this identification.

4. Bolt Installation:
   a. Bolts shall be installed with a hardened washer under the nut or bolt head, whichever is the element to be turned in the tightening. In addition, a hardened washer shall be used under the non-turned element of ASTM Designation: A 490 bolts if the material against which it bears has a specified minimum yield point less than 40 ksi. Bolts must be used with nuts and washers from the same rotational-capacity lot. Unless Lock-Pin and collar Connections are utilized according to paragraph 3.1.H, tightening of high strength bolts shall be accomplished by the "turn-of-nut" method according to paragraph 3.1.G.5. A Skidmore-Wilhelm Bolt Calibrator or equal is required on each job per paragraph 3.1.G.5.a.
   b. If the hole diameter is more than 1/16 inch greater than the nominal bolt diameter, hardened washers shall be placed under both head and nut.
   c. Where necessary, washers may be clipped on one side to a point not closer than seven-eighths of the bolt diameter from the center of the washer.
   d. Surfaces of bolted parts in contact with the bolt head, nut or flat hardened washer shall not have a slope of more than 1:20 with respect to a plane

normal to the bolt axis. When an outer face of the bolted parts has a slope of more than 1:20, a smooth hardened beveled washer shall be used to compensate for the lack of parallelism.

e. If required because of bolt entering and wrench operation clearances, tightening may be done by turning the bolt while the nut is prevented form rotating.

f. All bolts shall be tightened to give at least the required minimum bolt tension values shown in Table 1 on completion of the joint:

TABLE 1
Bolt Tension

Nominal Bolt Size, Inches	Minimum Tension in Pounds	
	ASTM A 325 Bolts	ASTM A 490 Bolts
1/2	12,000	15,000
5/8	19,000	24,000
3/4	28,000	35,000
7/8	39,000	49,000
1	51,000	64,000
1-1/8	56,000	80,000
1-1/4	71,000	102,000

5. Turn-of-Nut Tightening:

a. A representative sample of not less than three bolts and nuts of each diameter, length and grade to be used in the work shall be checked at the start of work in a device capable of indicating bolt tension (Skidmore-Wilhelm Bolt Calibrator or equal). The test shall demonstrate that the method of estimating the snug tight condition and controlling turns from snug tight to be used by the bolting crews develops a tension not less than 5 percent greater than the tension required by Table 1.

b. Bolts shall be installed in all holes of the connection and brought to a snug tight condition. Snug tight is defined as the tightness that exists when the plies of the joint are in firm contact. This may be attained by a few impacts of an impact wrench or the full effort of a man using an ordinary spud wrench. Snug tightening shall progress systematically from the most rigid part of the connection to the free edges, and then the bolts of the connection shall be retightened in a similar systematic manner as necessary until all bolts are simultaneously snug tight and the connection is fully compacted.

c. Following this initial operation all bolts in the connection shall be tightened further by the applicable amount of rotation specified in Table 2. During the tightening operation there shall be no rotation of the part not turned by the wrench. Tightening shall progress systematically from the most rigid part of the joint to its free edges.

TABLE 2
Nut Rotation from Snug Tight Condition

	Disposition of Outer Face of Bolted Parts		
Bolt length (Under side of head to end of bolt)	Both faces normal to bolt axis	One face normal to bolt axis and other face sloped not more than 1:20 (beveled washer not used)	Both faces sloped not more than 1:20 from normal to the bolt axis (beveled washer not used)
Up to and including 4 diameters	1/3 turn	1/2 turn	2/3 turn
Over 4 diameters but not exceeding 8 diameters	1/2 turn	2/3 turn	5/6 turn
Over 8 diameters but not exceeding 12 diameters	2/3 turn	5/6 turn	1 turn

Nut rotation is relative to bolt regardless of the element (nut or bolt) being turned. For bolts installed by 1/2 turn and less, the tolerance should be plus or minus 30 degrees; for bolts installed by 2/3 turn and more, the tolerance should be plus or minus 45 degrees.

6. ASTM Designation: A 490 bolts and galvanized ASTM Designation: A 325 bolts shall not be reused after having once been fully torqued. These same type bolts may be used for both fitting up and final bolting if tightened to no more than snug fit during fitting up. Other ASTM Designation: A 325 bolts may be reused after having been torqued only once if approved by the Engineer.

H. Lock-Pin and Collar Connections:

1. Connections shall be accurately fitted up before lock-pins are placed. A sufficient number of the holes at a connection point shall be filled with erection pins to "fair-up" all holes. Light drifting will be permitted, but drifting to match unfair holes will not be permitted. Such holes shall be reamed or drilled under the direction of the Engineer. Parts shall fit solidly together when assembled without interposition of gaskets or other compressible material.

2. When assembled, all joint surfaces, including those adjacent to the lock-pin heads and to the collars, shall be free of dirt, loose rust and scale, burrs and other defects that would prevent solid bearing of the parts. In addition, surface requirements shall be in accordance with Paragraphs 3.2.G.2.b, c, and d.

3. If the hole diameter is more than 1/16 inch greater than the nominal lock-pin diameter, hardened washers shall be placed under both the lock-pin head and collar, adjusting pin length if required for grip length. Where necessary, washers may be clipped on one side to a point not closer than seven-eighths of the nominal lock-pin diameter from the center of the washer. Surfaces of connected parts in contact with lock-pin head, collar or flat hardened washer shall not have a slope of more than 1:20 with respect to a plane normal to the lock-pin axis. When an outer face of the connected parts has a slope of more than 1:20, a smooth hardened beveled washer shall be used to compensate for the lack of parallelism.

4. Driving of lock-pin and collar fasteners shall be done by a special driving tool capable of producing the required tension in the shank of the fastener and capable of swaging the collar into the annular locking grooves, forming the collar to the proper size and shape as recommended by the manufacturer, before the pull-groove section is removed. The expendable pull-groove section shall be recovered from the driving tool as it breaks from the shank, and shall not be permitted to drop in such a manner as to create a hazard.

I. Welded Connections: Workmanship and technique, qualification of welders and welding operators, and inspection for field welded connections shown on the plans or authorized by the Engineer shall be in accordance with the ANSI/AASHTO/AWS D1.5 Bridge Welding Code.

J. Steel construction shall be cleaned and field painted in accordance with Section 04700, Protective Coatings for Steel Surfaces.

PART 4 MEASUREMENT AND PAYMENT

4.1 STEEL CONSTRUCTION

A. Measurement of Steel Construction: Steel Construction of the various classifications will be measured by the ton (2,000 pounds) of steel in the completed work. The weight of steel will be computed in accordance with Section 9 of the American Institute of Steel Construction "Code of Standard Practice."

B. Payment for Steel Construction:

1. Steel Construction shall be paid for at the contract unit price per ton (2,000 pounds) of steel of the various classifications measured in accordance with Paragraph 4.1.A. This price shall be full compensation for furnishing the material and protective coat application in accordance with Section 04700, Protective Coatings for Steel Surfaces, unless otherwise specified; and for all labor, tools, equipment, supplies, supervision, and incidentals necessary for unloading, hauling, and storing the materials; furnishing, placing, and removing erection falsework and special erecting devices when required; and erecting the steel and completing the work in accordance with the plans and these specifications.

2. The above provisions for payment shall not be interpreted to provide payment for steel piling, reinforcement, structure drain pipe, hardware and structural steel, including apron and deck plates, and bearing plates, incidental to other types of construction, or other items for which provision is otherwise made in the contract.

END OF SECTION

SECTION 04700

PROTECTIVE COATINGS FOR STEEL SURFACES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Cleaning and Painting

B. Hot Dip Galvanizing

C. Petrolatum Application

1.2 DESCRIPTION

A. These specifications shall govern the surface preparation, surface pretreatment, and application of protective coatings to steel structures and the steel portions of other structures, all in accordance with the plans, specifications and special provisions.

B. Weathering Steel:

1. ASTM Designation: A 588 or A 709, Grade 50W and ASTM Designation: A 852 or A 709, Grade 70W weathering steel, in order to provide a sound uniform surface for the formation of the protective oxide, shall be blast cleaned in the fabricating shop in accordance with the requirements of the Steel Structures Painting Council Specification SSPC-SP6 "Commercial Blast Cleaning."

2. Contamination of blast cleaned surfaces shall be avoided through the completion of work and all contaminants such as oil, grease and dirt shall be promptly removed.

3. Unless otherwise shown on the plans or in the special provisions, weathering steel shall not be shop or field painted.

1.3 PROTECTION AGAINST DAMAGE

A. The Contractor shall provide protective devices such as tarps, screens or covers as necessary to prevent damage to the work and to other property or persons from all cleaning and painting operations.

B. Paint or paint stains that result in an unsightly appearance on surfaces not designated to be painted shall be removed or obliterated by the Contractor at the Contractor's expense and to the satisfaction of the Engineer.

C. All painted and galvanized surfaces that are marred or damaged as a result of operations of the Contractor shall be repaired by the Contractor, at the Contractor's expense, with materials and to a condition equal to that of the coating specified.

D. Upon completion of all painting operations and of any other work that would cause dust, grease, or other foreign materials to be deposited upon the painted surfaces, the painted surfaces shall be thoroughly cleaned.

1.4 HANDLING, STORAGE AND SHIPPING

A. All blocks, chains, slings, braces, clamps, etc., used in the handling, moving, storing and shipping of painted and galvanized members shall be padded in such a manner that the coating will not be damaged.

B. Articles shall be loaded and stored to prevent the formation of wet storage stains.

1. The material shall be loaded in such a manner that continuous drainage could occur.

2. In storage, the articles shall be raised from the ground and, if necessary, separated with strip spacers to provide free access of air to most parts of the surface. They shall also be inclined in a manner which will give continuous drainage. Under no circumstances shall the steel be allowed to rest on cinders nor shall it be stored on wet soil or decaying vegetation.

1.5 WEATHER CONDITIONS

A. Protective coatings shall be applied only on thoroughly dry surfaces and during periods of favorable weather.

B. Painting will not be permitted when the atmospheric temperature, paint, or the surface to be painted is at or below 40 degree or above 100 degree F, or when metal surfaces are less than 5 degree F above the dew point, or, unless approved in writing by the Engineer, when the humidity exceeds 80 percent at the site of the work.

C. Application of paint will not be permitted when freshly painted surfaces may become damaged by rain, snow, fog, or condensation, or when it can be anticipated that the atmospheric temperature or relative humidity will not remain within the specified application conditions during the drying period, except as provided in Paragraph 1.6.E. for enclosures.

D. Painting shall not be done when the steel is hot enough to cause the paint to blister or produce a porous paint film.

E. Subject to approval by the Engineer in writing, the Contractor may provide suitable enclosures to permit painting during inclement weather. Provisions shall be made to control atmospheric conditions artificially inside the enclosures within limits suitable for painting throughout the painting operation and drying period. Full compensation for providing and maintaining the enclosures shall be considered as included in the prices paid for the various contract items of work requiring paint and no additional compensation will be allowed therefor.

F. If fresh paint is damaged by the elements, it shall be replaced or repaired by the Contractor at the Contractor's expense.

G. If, in the opinion of the Engineer, there is an objectionable amount of dust in the atmosphere, the contractor shall, at his own expense, take necessary precautions to prevent dust and dirt from coming in contact with freshly painted surfaces or with surfaces before the paint is applied.

1.6 SURFACES IN CONTACT WITH CONCRETE

A. Tops of beams and girders that are to have concrete cast in contact with them shall not be painted. Steel that is to be completely embedded in concrete shall not be painted.

B. Pile plate surfaces, including shear stud connectors, in contact with and embedded in concrete shall not be painted. The exposed portion of pile plates shall be field cleaned and painted as specified in Paragraph 3.7.

C. Care shall be taken when painting steel that is in contact with concrete to insure full paint coverage on the steel. Concrete surfaces shall be masked or covered as necessary to prevent surface contamination. Paint on concrete surfaces shall be removed, at the Contractor's expense, in a manner approved by the Engineer.

1.7 CONTACT AND INACCESSIBLE SURFACES

A. Surfaces in contact to be welded or bolted in the shop shall not be painted unless specified, but shall be cleaned of loose rust, scale and foreign material to meet the approval of the Engineer. Field contact surfaces shall not be painted. Surfaces not in contact, but which will be inaccessible after assembly or erection, shall be painted in the shop with the shop and field coats of the paint system required for the completed structure.

B. The bottom surfaces of masonry plates and surfaces of structural steel to be in contact with elastomeric bearing pads or preformed fabric pads shall be cleaned and painted with the full number of paint coats prior to erection.

1.8 MACHINE FINISHED SURFACES

A. Machine finished surfaces of pins, pin holes, rollers or other finished surfaces that will be subject to friction, shall be coated as soon as practicable after being approved, with lacquer or an anti-rust compound. When anti-rust compound is used, it shall be removed at the time of erection.

B. While still in the shop, machine finished surfaces and inaccessible surfaces of rocker or pin-type bearings shall receive the full paint system.

1.9 ERECTION MARKS

A. Erection marks and match marks shall be painted upon areas not visible to view after erection or upon areas that have received the shop paint.

1.10 SIGNS AND EMBLEMS

A. When designated, signs and/or company emblems as shown on the plans shall be painted on specified structures by qualified sign painters. This work shall not be started until the underlying finish coat is completely dry and the exact locations have been specified by the Engineer.

PART 2 MATERIALS

2.1 PAINT

A. Paint systems and materials shall be as specified on the plans or in the special provisions.

2.2 ZINC FOR GALVANIZING

A. Zinc for galvanizing shall conform to ASTM Designation: B 6 and the requirements stated in ASTM Designations: A 123 and A 153 as applicable.

B. Galvanized repair paint, Zinc Dust-Zinc Oxide Type I linseed oil paint, shall meet the Federal Specification, TT-P-641.

2.3 PETROLATUM

A. Petrolatum is a rust inhibiting grease coating applied over surfaces free of loose rust, scale, and paint and shall be subject to the approval of the Engineer.

PART 3 EXECUTION

3.1 CLEANING AND PREPARATION OF ALL SURFACES TO BE PAINTED

A. Unless otherwise prohibited by the special provisions, solvents shall be used to remove oil, grease, and other soluble contaminants in accordance with the requirements of the Steel Structures Painting Council Specification, SSPC-SP1, "Solvent Cleaning." Solvent cleaning shall be performed prior to blast cleaning. If contamination remains after blasting, the area shall be recleaned with solvent.

B. After solvent cleaning, if permitted, all surfaces to be painted shall be blast cleaned in accordance with the requirements of the Steel Structures Painting Council Specification, SSPC-SP6, "Commercial Blast Cleaning." Special attention shall be given to the cleaning of corners and re-entrant angles. All cleaned surfaces shall have an anchor profile of 1 to 2.5 mils.

C. Abrasives used for blast cleaning shall be either clean dry sand, mineral grit, steel shot, or steel grit, at the option of the Contractor, and shall have a suitable grading to produce satisfactory results. The use of other abrasives will not be permitted unless approved in writing by the Engineer. Unwashed beach sand containing salt or excessive amounts of silt will not be allowed.

D. Before painting, all blast products shall be removed from the surfaces, and the cleaning shall be approved by the Engineer. The blast cleaned surfaces shall be given a coat of paint within 24 hours after cleaning, unless otherwise authorized by the Engineer. The surface must be painted before rust forms.

E. In repainting existing steel structures the method of cleaning will be specified in the special provisions. Any damage to sound paint, on areas not designated for treatment, resulting from the Contractor's operations shall be repaired by the Contractor at the Contractor's expense to the satisfaction of the Engineer.

3.2 PAINT APPLICATION

A. Surfaces shall be painted as soon as practicable after they have been properly cleaned and approved for painting by the Company's inspector. Blast cleaning and painting operations shall be coordinated so that at all times the blast cleaning work will be carried on a sufficient distance from freshly painted surfaces to preclude any adhesion of grit in the fresh paint.

B. All painting shall be done in accordance with the requirements of the Steel Structures Painting Council Specification, SSPC-PA1, "Shop, Field and Maintenance Painting."

C. Unless otherwise specified three coats of paint shall be applied to all new structural steel (except "Weathering Steel"). The prime and intermediate coats shall be applied in the fabricating shop. The finish coat shall be applied in the field after erection. The dry film thickness of each coat shall be as specified on the plans or in the special provisions. Each coat shall differ enough in color from its preceding coat to make it easy to see voids in the fresh paint. Colors shall be as stated on the plans or special provisions as the Engineer directs. The final coat on any surface exposed to view shall be made with paint from a common batch. The Contractor shall provide the Engineer with a written method for verifying and certifying that the final coat is, in fact, from a common batch.

3.3 SHOP PAINTING

A. Shop painting shall include the furnishing of all shop applied paint, the preparation and cleaning of surfaces, the application, drying and protection of the shop applied paint; and the supplying of all materials, tools and labor necessary to complete the work.

B. Refer to Paragraph 1.6 for surfaces in contact with concrete, Paragraph 1.7 for contact and inaccessible surfaces, and Paragraph 1.8 for machine finished surfaces.

C. The fabricated steel shall not be loaded for shipment until the shop paint is dry and has been inspected and approved by the Engineer. Structural steel shall not be loaded for shipment sooner than 24 hours after application of paint. No painting shall be done after the material has been loaded for shipment.

3.4 FIELD PAINTING

A. Field painting following shop painting and steel erection shall include the furnishing of all field applied paint, the cleaning of all surfaces as required, the application of the prime and intermediate coats on all surfaces not painted in the shop and on all shop painted surfaces damaged during handling and erection, the application, drying and protection of the finish paint coat and the supplying of all materials, tools and labor necessary to complete the work, including signs and emblems, and to protect surfaces not to be painted from contamination.

B. Field painting of steel not previously shop painted shall include the furnishing of all field applied paint, the cleaning of all surfaces, the application of the field applied paint coat, or coats as specified; and the supplying of all materials, tools and labor necessary to complete the work, including signs and emblems, and to protect surfaces not to be painted from contamination.

3.5 REMOVAL OF UNACCEPTABLE COATINGS

A. All coatings applied improperly or which fail to dry or adhere properly, or do not evidence a normal, workmanlike appearance shall be remedied or completely removed and replaced under the direction of the Engineer and at the expense of the Contractor.

B. When the final field coat does not have a uniform color and appearance throughout the structure, it shall be corrected by the use of whatever additional coats or other corrective measures found to be necessary. Freshly applied paint which has not yet set shall be removed with the use of suitable solvents. Removal of dried paint films shall be either by means of blast cleaning, scraping, or other methods meeting the approval of the Engineer.

3.6 INSPECTION

A. All material and workmanship shall be subject to inspection by the Company's inspector.

B. The Contractor shall provide all reasonable facilities, labor, materials, equipment, scaffolding and assistance for the safe and convenient conduct of all inspections.

C. All surfaces will be inspected and approved prior to completion or proceeding to the next order of work.

D. Such inspections shall not relieve the Contractor's responsibility for furnishing qualified labor, materials and workmanship in strict accordance with these specifications.

E. Any work performed or results achieved which are not in strict accordance with these specifications shall be redone to meet these specifications at the Contractor's expense.

3.7 GALVANIZED STEEL

A. When designated on the plans or in the special provisions, steel shall be galvanized as follows:

1. Steel members, fabrications, and assemblies shall be galvanized after fabrication by the hot dip process in accordance with ASTM Designation: A 123.

2. Bolts, nuts and washers and iron and steel hardware components shall be galvanized in accordance with ASTM Designation: A 153.

B. After galvanizing, all elements shall be free of fins, abrasions, rough or sharp edges, and other surface defects. The galvanized coating shall be continuous, adherent, as smooth and evenly distributed as possible and free from any defect that is detrimental to the coated article.

C. Damaged galvanized surfaces shall be thoroughly cleaned to remove all contaminants including weld slag, weld splatter, and rust and shall then be painted with two coats of galvanized repair paint meeting the requirements of Paragraph 2.2.B.

3.8 PETROLATUM APPLICATION

A. Petrolatum application shall include the furnishing of petrolatum as specified in Paragraph 2.3, the cleaning of surfaces to remove loose rust, scale and dirt; the application of an approximately 1/32 inch thick coating on surfaces designated on the plans, in the special provisions or by the Engineer; and the supplying of all materials, tools and labor necessary to complete the work.

PART 4 MEASUREMENT AND PAYMENT

4.1 PROTECTIVE COATINGS FOR STEEL SURFACES

A. Protective coatings for steel surfaces including surface cleaning and preparations, shop painting, field painting, hot dip galvanizing of steel items and petrolatum application shall be considered as incidental to other items of work and no measurement nor direct payment will be made therefor.

END OF SECTION

SECTION 04900

ELASTOMERIC BEARING PADS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Plain Elastomeric Bearing Pads

B. Laminated Elastomeric Bearing Pads

1.2 DESCRIPTION

A. Elastomeric bearing pads covered by this section includes plain pads consisting of elastomer only and laminated pads consisting of alternate laminations of elastomer and steel sheets bonded together.

1.3 CERTIFICATION

A. The bearing pad supplier shall certify that the elastomer, and steel sheets if used, in the bearing pads that are furnished for each order conform to all of the requirements of Paragraphs 2.1 and 2.2. The certification shall be supported by a certified copy of the results of tests performed by the manufacturer upon samples of the elastomer and steel sheets that were used in the bearing pads.

PART 2 MATERIALS

2.1 ELASTOMER

A. The elastomer for bearing pads shall be formulated from previously unvulcanized 100 percent virgin polychloroprene (neoprene) and shall, as determined from test specimens prepared in accordance with ASTM Designation: D 3190, conform to the following:

ASTM Designation	Test	Requirement
D 2240	Hardness, Type A Durometer	60 +/- 5
D 412	Minimum Tensile Strength in MPa	17
	Minimum Elongation at break, %	350
D 573	Heat Resistance, Oven Aged 70 hrs at 100 deg. C.	
	Change in durometer hardness, max. points	0 to +15
	Change in tensile strength, max. %	-15
	Change in ultimate elongation, max. %	-40
D 395	Compression Set, 22 hrs. at 70 deg. C., Method B, max. %	25

D 1149	Ozone Resistance, 1 ppm in Air by volume, 20% strain, 40 +/- 1 deg. C., mounting procedure D 518 Procedure A	No cracks after 100 hrs. exposure
D 2137	Low Temperature Brittleness, at -40 deg. C.	Pass
D 624	Tear Resistance, Die "C", min. N/m	43,775

2.2 STEEL SHEETS

A. Steel sheets for use in laminated bearing pads shall meet the requirements of ASTM Designation: A 570, Grade 36.

2.3 METHYL ETHYL KETONE

A. Methyl ethyl ketone for use in cleaning of elastomeric bearing pads shall meet the requirements of ASTM Designation: D 740, Type 1 or Type 2.

2.4 GEL TYPE EPOXY

A. The gel type epoxy shall be a two component, epoxy-resin bonding system conforming to the requirements of ASTM Designation: C 881, Type IV, Grade 2, Class B or C. The class supplied shall be governed by the range of temperatures for which the material is to be used.

PART 3 EXECUTION

3.1 PLAIN BEARING PADS

A. Plain bearing pads shall be cast in molds under pressure and heat and may be molded individually, cut from previously molded strips or slabs molded to the full thickness of the finished bearings, or extruded and cut to length. Plain bearing pads shall be fully vulcanized, uniform and integral units of such construction that the bearing pad cannot be separated by any mechanical means into separate, definite and well-defined elastomeric layers. Evidence of layered construction shall be cause for rejection.

B. Cutting of plain bearing pads from previously molded strips or slabs shall be performed in such a manner as to avoid heating of the material and to produce an edge, with no tears or other jagged areas, having a surface roughness that does not exceed ANSI/ASME B46.1, 250.

3.2 LAMINATED BEARING PADS

A. Laminated bearing pads shall have alternate layers of elastomer and steel sheets as shown on the design drawings, and shall be cast in individual molds under heat and pressure to form an integral unit of such construction that the bearing pad cannot be separated by any mechanical means into separate, definite and well-defined elastomeric layers. Evidence of layered construction shall be cause for rejection.

B. The top and bottom steel sheets and the edges of all steel sheets shall be uniformly covered with not less than 1/8 inch of elastomer. The maximum cover of elastomer over the edges of steel sheets shall be 1/4 inch. Steel sheets shall be abrasive blast cleaned to remove all rust, mill scale, and other contaminates, and shall be free of sharp edges and burrs.

3.3 TOLERANCES

A. For both plain and laminated bearing pads the permissible variation from the dimensions and configuration required by the plans and these specifications shall be as follows:

1.	Overall vertical dimensions	
	Average total thickness 1-1/2" or less	-0, +1/8"
	Average total thickness over 1-1/2"	-0, +1/4"
2.	Overall horizontal dimensions -0, +1/4"	
3.	Thickness of individual layers of elastomer (laminated bearing pads only)	+/-1/8"
4.	Variation from a plane parallel to the theoretical surface	
	Top	1/8"
	Sides	1/4"
	Individual Steel Sheets	1/8"
5.	Size of holes or slots	-0, +1/8"
6.	Position of holes or slots	+/-1/8"

3.4 INSTALLATION

A. Elastomeric bearing pads shall be installed in accordance with the plans. Substructure bearing surfaces to receive the bearing shall be level, smooth, and finished to the correct elevation. The entire bearing surface shall be fully loaded under all conditions.

B. Top and bottom elastomer surfaces shall be level under dead load only. Tapered load plates bonded to the bearing, tapered sole plates on the bridge span, or epoxy mortar between the bearing and the bridge span, as specified on the plans, shall compensate for span grade, rotation, or camber.

C. Welding of bridge span members to the bearing load plate is not permitted unless there is more than 1-1/2 inches of steel between the weld and the elastomer. The temperature of the steel plate in contact with the elastomer shall not exceed 400 degrees F during the welding process.

D. Bearing areas on bridge seats and precast concrete beams, which are to receive epoxy materials, shall be abrasive blast cleaned to remove all form oil and curing agents and shall be in a dust free condition. Bearing areas on steel bearing plates, which are to receive epoxy materials, shall be cleaned of all dirt, grease, and other contaminants before epoxy materials are applied.

E. Clean top and bottom surfaces of bearing pads with methyl ethyl ketone to remove all traces of mold release agents. When mating surfaces are clean and dry, gel type epoxy as specified in Paragraph 2.4.A shall be applied to a 5 mil thickness on the areas of the bridge seat where elastomeric bearing pads are to be placed, and on the bottom side of the elastomeric bearing pads and then the pads shall be set and held in the proper location on the bridge seat until the epoxy takes its initial set. Pads must be held down with sufficient weight to ensure total pad contact on the bridge seat.

F. When epoxy mortar is specified to compensate for span, grade, rotation, or camber, mortar consisting of equal parts by volume of gel type epoxy as specified in Paragraph 2.4.A and dry silica sand, mixed in accordance with manufacturer's directions, shall be spread on top of bearing pads to a thickness of approximately 1/8 inch just before setting beams in order to obtain uniform bearing. The beams shall be set in the proper location on the bearing pads before the epoxy mortar takes its initial set. Scrape excess mortar from around bearing pads after beams are set.

PART 4 MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

A. Elastomeric bearing pads will be measured by each elastomeric bearing pad.

4.2 PAYMENT

A. Elastomeric bearing pads will be paid for at the contract unit price per each elastomeric bearing pad in place. This price shall include full compensation for furnishing all materials, and for all labor, tools, equipment, and incidentals necessary to complete the work.

END OF SECTION

APPENDIX A
GEOTECHNICAL INFORMATION

HWA GEOSCIENCES INC.
Geotechnical & Pavement Engineering · Hydrogeology · Geoenvironmental · Inspection & Testing

February 26, 2010
HWA Project No. 2007-142-21

AECOM Transportation
10900 NE 8th Street, Suite 750
Bellevue, Washington 98004

Attention: Kiva Lints, P.E., S.E.

Subject: **Geotechnical Evaluation Report**
Willow Creek Culvert Replacement under BNSF Mainline
Edmonds, Washington

Dear Mr. Lints:

As requested, HWA GeoSciences Inc. (HWA) completed a geotechnical evaluation in support of the design and construction of the proposed replacement culvert located under the BNSF Mainline. The purpose of our work was to evaluate subsurface conditions at this location and to provide geotechnical recommendations for this project. This final report incorporates your comments on an initial draft report, and presents our findings, assumptions and recommendations.

PROJECT DESCRIPTION

As part of the Seattle to Everett Commuter Rail project for Sound Transit, BNSF is constructing a second mainline track. In this area, the work is referred to as the Edmonds Double Track Project. The second track will be located on the east (upland) side of the existing mainline. Willow Creek currently extends below the single mainline tracks in a culvert. The subject project involves construction of single-span bridge at a future creek under-crossing. Figure 1 is a Vicinity Map showing the project location.

As part of the future Washington State Ferry's Edmonds Multi-Modal project, Willow Creek will be re-routed south along the east (upland side) of the existing mainline approximately 700 feet. The creek will then be routed to the west and will cross beneath the mainline tracks, where it will traverse the City of Edmonds Off Leash Dog Park, and enter Puget Sound. After evaluation of costs and constructability issues associated with various culvert options, Sound Transit selected a single-span railroad bridge to be constructed for this under-crossing.

In order to keep the existing mainline track open for freight during this construction, the bridge structure will be constructed in stages. **Stage 1** will shift the existing mainline tracks slightly to the east approximately

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4 feet to the proposed AO-MT2 location; construct temporary shoring; and construct the western portion of the new bridge. **Stage 2** will include constructing the tracks at the proposed AO-MT1 location on the western portion of the bridge, shifting the active railroad traffic to the AO-MT1; removing the temporary shoring between the new bridge abutments; and constructing the remaining portion of the bridge. In the **Final Stage**, the proposed tracks at AO-MT2 will be constructed and both sets of tracks will be open.

This geotechnical engineering report provides recommendations for design and construction of the railroad bridge structure.

SUBSURFACE CONDITIONS

General Geologic Conditions

Geologic information was obtained from *Preliminary Surficial Geologic Map of the Edmonds East and Edmonds West Quadrangles, Snohomish and King Counties, Washington* (Mackey Smith, 1975). This map indicates the surficial geology in the project vicinity consists of deposits from the Whidbey Formation. The Whidbey Formation can be expected to consist of sand, silt, and clay, bedded 2 to 4 feet thick, with particle sizes ranging from clay to coarse sand. This map also indicates that much of the area consists of Modified Land, which is land disturbed by removal, grading and artificial fill of unknown quality.

Exploration

We conducted a site subsurface exploration program on July 16 and July 17, 2008. The subsurface investigation consisted of two borings; each drilled two depths of 41.5 feet below the ground surface (bgs). Our boring BH-1 was located east of the BNSF Mainline and BH-2 was located to the west of the BNSF Mainline. Figure 2 is a Site and Exploration Plan illustrating the approximate locations of our borings. The borings were drilled by Holocene Drilling, under subcontract to HWA, using a CME-850 track mounted drill rig with a hollow stem auger. Soil samples were taken every two and a half (2½) feet to a depth of 20 feet and taken every five (5) feet thereafter. Sampling was accomplished in general accordance with the Standard Penetration Test (SPT), which consists of driving a 2-inch outside diameter (OD) and 1.375-inch inside diameter split-spoon sampler 18 inches into the soil. The sampler is advanced using a 140-pound hammer freely-falling a distance of 30 inches onto the sampling rods. The number of blows required to advance the sampler each of three 6-inch intervals is recorded. The SPT N-value is the total number of blows required to advance the sampler the final 12 inches. The N-value provides and indication of the relative density of the granular materials encountered in our borings. Boreholes were backfilled using bentonite chips. A slotted standpipe monitoring well (piezometer) was installed in BH-2 to monitor groundwater conditions.

Figure 3 is a legend of terms and symbols used on HWA borings. Our logs of borings BH-1 and BH-2 are presented in Figures 4 and 5, respectively.

Sampling and Testing

SPT soil samples were taken at 2½- to 5-foot intervals. An HWA geologist inspected and logged each sample, recording pertinent information including soil sample depths, stratigraphy, ground water occurrence, and any visual or olfactory observations regarding the presence of contamination.

Soil samples were logged with respect to lithology and field screened for organic vapors by headspace analysis using a photoionization detector (PID). HWA conducted field screening of soil from the borings for the presence of volatile organic vapors using a Mini-Rae PGM 75 photoionization detector (PID). Any visual indications of contamination and odor were also noted. Although the PID is not capable of quantifying or identifying specific organic compounds, this instrument is capable of measuring relative concentrations of a variety of organic vapors with ionization potentials less than the energy of the ultraviolet source (in this case, 10.6 eV). The PID is useful for providing qualitative information with respect to the presence and relative concentration of organic vapors.

The PID was calibrated with 100 parts per million isobutylene standard at the beginning of the day. Fifty to 100 milliliters of soil from a discrete depth were placed in a plastic bag, sealed, and permitted to sit at least 10 minutes prior to analyzing the vapor in the sample bag. The bag was then perforated by the PID sample tip to obtain the reading.

No samples were detected with elevated levels of organic vapors or discernible visual/olfactory contamination. Due to the absence of field screening indications, a composite sample of above ground water material was submitted for analysis.

We submitted the composite soil sample to Onsite Environmental Laboratory for analysis. HWA delivered samples to the laboratory within 24 hours of sampling and employed full chain-of-custody procedures to allow tracking and handling of the samples. Analytical results, shown in Table 1, show no elevated hydrocarbon levels in the composite sample.

Of the remaining collected soil samples, select samples were chosen to further characterize relevant engineering and index properties of the site soils. These tests were performed at HWA's laboratory in Lynnwood, Washington and included tests for natural moisture content and grain size distribution, Figures 4-7 respectively. HWA personnel performed laboratory tests in general accordance with appropriate ASTM standards.

Table 1: Analytical Soil Data (reported in milligrams per kilogram, mg/kg)

			Petroleum Hydrocarbons			Aromatic Hydrocarbons			
Sample ID	**Sample Description**	**PID Reading (ppm)**	**Diesel**	**Lube Oil**	**Gasoline**	**Benzene**	**Toluene**	**Ethylbenzene**	**Xylenes**
BH-2-Comp	*Sand*	*0*	*<28*	*<55*	*<5.3*	*<0.02*	*<0.053*	*<0.053*	*<0.053*
MTCA Method A Cleanup Level			2000	2000	30/100*	0.03	7	6	9

Notes:
MTCA A – Ecology MTCA Method A soil cleanup levels, Chapter 173-340 WAC, shown for reference only. These cleanup levels may not apply at this site, and are provided as a screening level indication of the environmental quality of the site only. All values are in milligrams per kilogram (mg/kg)
* - The Method A Soil cleanup levels for gasoline mixtures without benzene and the total of ethylbenzene, toluene, and xylenes are less than 1% of the gasoline mixture are 100 mg/kg/all other mixtures are 30 mg/kg.
All diesel range hydrocarbon sample extracts treated with an acid/silica gel cleanup procedure.

Site Soil Conditions

The first borehole, BH-1, was completed on July 16, 2008. Groundwater was encountered at about 7 feet below grade surface (bgs). The upper 20 feet primarily consisted of silty, fine to medium grained sand. SPT blow counts indicate that this material is loose to medium dense. At approximately 17.5 feet a one-foot thick layer of slightly gravelly organic silt was discovered. Below 17.5 feet, dense, slightly gravelly, fine to medium sand was encountered to the bottom of the boring at 41.5 feet bgs.

The second borehole, BH-2, was completed on July 17, 2008. Groundwater was encountered at approximately 9.5 feet bgs during drilling. The upper 15 feet consisted of loose to medium dense fine to coarse sand. Below 15 feet, the material then became dense to very dense, gravelly, silty sand to the bottom of the boring at 41.5 feet bgs.

We interpreted the native sand encountered in BH-1 and BH-2 to be part of the Whidbey Formation. Our interpretation of the site soil conditions apply only to the locations at which we drilled.

It is also important to note that ground water conditions are reported for the specific date and locations indicated and, therefore, may not necessarily be indicative of other times and/or locations. It is anticipated that ground water conditions will vary depending on the season, local subsurface conditions, tides, and other factors. Ground water measurements were recorded using a pore pressure transducer during the months of January and February for approximately 10 days. As is evident from Figure 9, the ground water table fluctuates about 1 foot with tidal fluctuations. The average ground water table is approximately Elevation + 6.5.

CONCLUSIONS AND RECOMMENDATIONS

Pile Foundations for Permanent Bridge

The permanent single-span bridge will be constructed in accordance with BNSF Standard Bridge Plans, which call for steel H-piles for foundation support. The proposed H-piles are HP 14x89. The project Plans call for these piles to be driven to achieve ultimate capacities of 250 tons.

Dense sand was encountered in our borings below approximate Elevation minus 15 feet, and pile driving resistance will increase below this tip elevation. However, given the low-displacement nature of H-piles, there is a possibility that the piles will achieve significantly greater penetration depths before required ultimate axial capacities are achieved. Actual required penetration depth is difficult to predict accurately. The contractor should be prepared to field-splice additional pile length as necessary. For planning purposes, minimum pile tip elevation of minus 25 feet (-25 ft) should be assumed. Steel H-piles should be measured and paid for on a unit-price basis.

Pile capacities and final pile tip elevation, should be verified in the field at the time of driving. A vibratory pile driving hammer could be utilized for initial pile placement and driving. However, final driving must be done with an impact hammer, so that pile capacities can be verified. BNSF Standard Bridge Plans call for pile capacity to be determined using the Modified ENR formula. However, in our opinion, the Modified ENR formula is outdated and in some cases un-conservative. We recommend that pile capacity be determined using the wave equation analysis of pile driving (WEAP). HWA is available to provide during-construction assistance and evaluation of pile capacity if requested.

Temporary Shoring

As indicated on the construction sequence and bridge layout drawings provided by AECOM Transportation, temporary shoring will be required to facilitate the staged construction. Drawings indicate the maximum exposed height of the temporary shoring will be about 12 feet. The temporary shoring will be in close proximity to the active main line, and thus, it will need to support the lateral influence of train live loading.

From a shoring installation perspective, the soils encountered in our borings are suitable for shoring installation with using vibratory pile driving equipment. Either interlocking steel sheet piles or steel soldier piles with timber lagging could be considered for shoring. However, the average ground water level is at approximate Elevation +6.5; and temporary excavations will extend down to approximate Elevation +4 feet. Thus, the excavations will extend 2.5 feet or greater below the ground water level. . For this reason, we consider interlocking steel sheet piling would be more effective temporary shoring than soldier piles and timber lagging. The interlocking steel sheets will tend to cut off and reduce the amount of water flowing past the shoring and into the excavated creek channel. Ultimately the Contractor should be responsible to design and install the temporary shoring.

Figure 8 presents recommended earth and ground water design pressures for the temporary shoring. Due to its proximity to the active main line, the temporary shoring design must also be designed to accommodate live load effects from a Cooper E80 train. BNSF live loading requirements are presented in the BNSF and Union Pacific *Guidelines for Temporary Shoring*. The Cooper E80 lateral surcharge pressures - determined in accordance with the *Guidelines for Temporary Shoring* - should be added to the soil and ground water pressures presented in Figure 8. The Contractor should be required to submit the temporary shoring design to AECOM Transportation and HWA for review and approval.

Temporary Excavations and Dewatering

Temporary excavations should be performed in accordance with the current requirements of federal, state and/or local agencies. Exposure of personnel beneath temporary cut slopes should be kept to a minimum. Construction should proceed as rapidly as feasible, to limit the time temporary excavations are open. During wet weather, runoff water should be prevented from entering excavations, and should be collected and disposed of outside the construction limits. Heavy construction equipment, building materials, and surcharge loads such as excavated soil should not be allowed within 1/3 the slope height from the top of any excavation.

Per the Washington Administrative Code 296-155, site soils classify as Type C soils and may be constructed no steeper than 1.5H:1V (horizontal:vertical). Specific design for temporary slopes is not included herein, since the contractor has control over factors during construction that are critical to the stability of the slope. Such factors include the amount of slope opened at one time, the length of time the slope is left open, and to some extent when the slope is left open in terms of weather conditions. Thus, maintaining safe and stable temporary excavations is the responsibility of the contractor.

With time and the presence of seepage and/or precipitation, the stability of temporary unsupported cut slopes can be significantly reduced. Therefore, all temporary slopes should be protected from erosion by installing a surface water diversion ditch or berm at the top of the slope and by covering the cut face with well-anchored plastic sheets. In addition, the contractor should monitor the stability of the temporary cut slopes and adjust the construction schedule and slope inclination accordingly.

Excavations to the proposed stream channel elevation will be about 2.5 feet below the average ground water level. The contractor should be prepared to deal with groundwater during construction. Design and implementation of any dewatering system is the responsibility of the contractor.

Wet Weather Earthwork

Existing site soils are moisture sensitive to varying degrees, and may be difficult to handle or traverse with construction equipment during periods of wet weather. Therefore, general recommendations relative to earthwork performed in wet weather or in wet conditions are presented below. These recommendations should be incorporated into the contract specification and should be required when earthwork is performed in wet conditions:

1) Site stripping and fill placement should be accomplished in small sections to minimize exposure to wet weather. Excavation or removal of unsuitable soil should be followed promptly by placement and compaction of a suitable thickness of clean structural fill. The size and type of construction equipment used may have to be limited to prevent soil disturbance.

2) Material used as structural fill should consist of clean granular soil, of which not more than 5% passes the U.S. Standard No. 200 sieve, based on wet sieving the fraction passing the ¾-inch sieve. The fine-grained portion of structural fill soils should be non-plastic.

3) No soil should be left uncompacted so it can absorb water. Stockpiles of excavated soil should either be shaped and the surface compacted, or covered with plastic sheets. Soils that become too wet should be removed and replaced with clean granular materials.

4) Excavation and placement of fill should be monitored by someone experienced in wet weather earthwork to determine that the work is being accomplished in accordance with the project specifications and the recommendations contained herein.

Qualifications and Limitations

We prepared this letter report for use by Sound Transit and AECOM Transportation, for use in the design of a portion of this project. This report should be provided in its entirety to prospective contractors for their bidding or estimating purposes, but our conclusions and interpretations should not be construed as a warranty of the subsurface conditions. Experience has shown that soil and ground water conditions can vary significantly over small distances. Inconsistent conditions can occur between explorations and may not be detected by a geotechnical study. If, during future site operations, subsurface conditions are encountered which vary appreciably from those described herein, HWA should be notified for review of the recommendations of this letter report, and revision of such if necessary.

This report is issued with the understanding that it is the responsibility of the owner to ensure that the information and recommendations contained herein are brought to the attention of the appropriate design team personnel and incorporated into the project plans and specifications. It is also the owner's responsibility to see that the necessary steps are taken to verify that the contractor and subcontractors carry out these recommendations in the field.

Our work included environmental testing of soil samples retrieved from our borings. These samples and tests did not reveal elevated hydrocarbon levels. However, there is always a possibility that contaminated or hazardous substances may be encountered at other locations during construction.

HWA does not practice or consult in the field of safety engineering. We do not direct the contractor's operations and we cannot be responsible for the safety of personnel other than our own on the site. The safety of others is the responsibility of the contractor. The contractor should notify the owner if any of the recommended actions presented herein are considered unsafe.

We appreciate this opportunity to provide geotechnical engineering services on this project. If you have any questions or if we may be of further assistance, please contact the undersigned at (425) 774-0106.

Sincerely,

HWA GEOSCIENCES INC.

ERIK O. ANDERSEN
STATE OF WASHINGTON
36468
REGISTERED
PROFESSIONAL ENGINEER

Feb 26, 2010

Erik O. Andersen, P.E.
Senior Geotechnical Engineer

David S. Maloney
Geotechnical Engineer

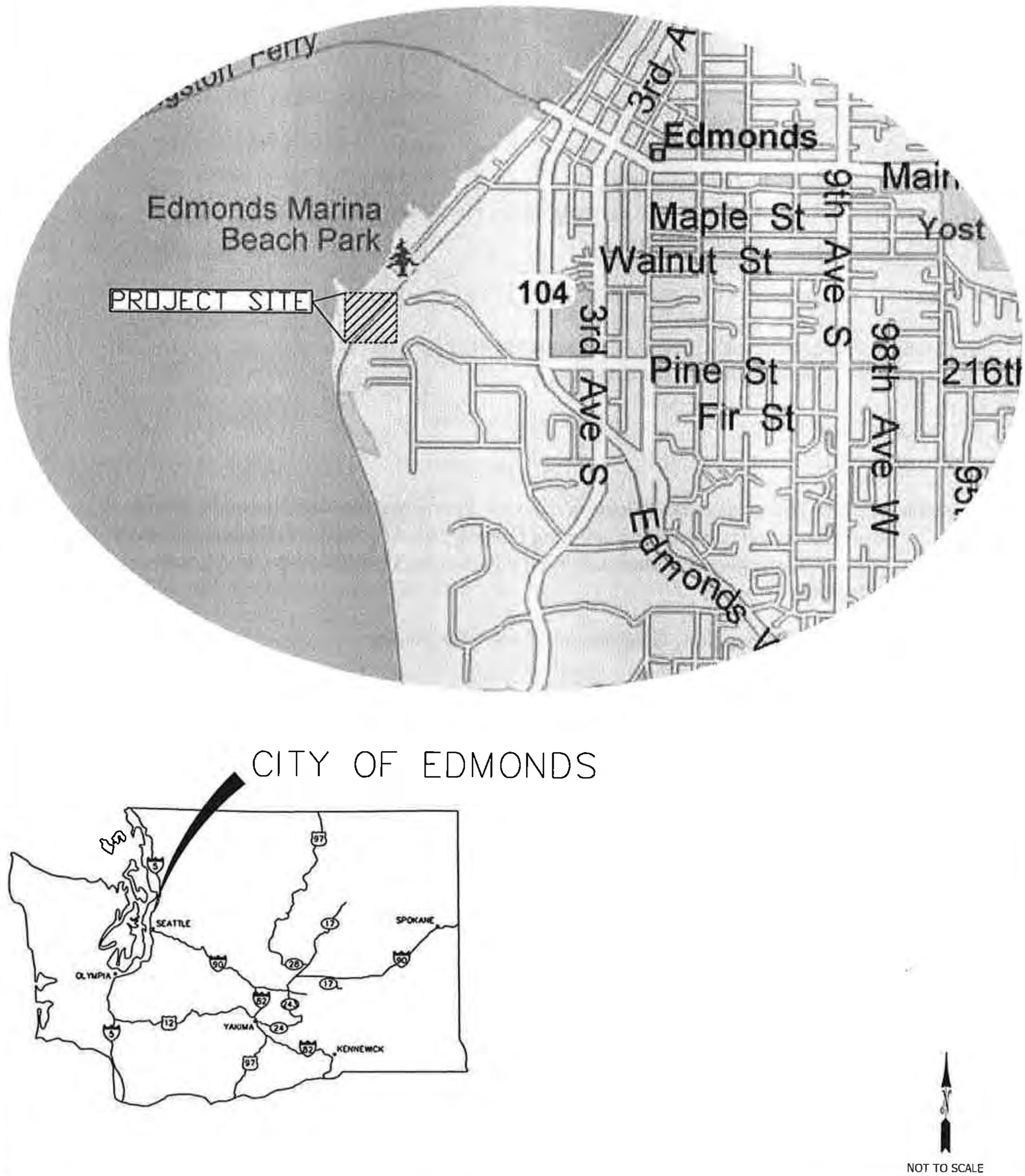
ATTACHMENTS:

Figure 1.	Vicinity Map
Figure 2.	Site and Exploration Plan
Figure 3.	Legend of Terms and Symbols Used on Explorations
Figure 4.	Log of Borehole BH-1
Figure 5.	Log of Borehole BH-2
Figure 6.	Grain Size Distributions, BH-1
Figure 7.	Grain Size Distributions, BH-2
Figure 8.	Lateral Earth Pressure for Temporary Shoring
Figure 9.	Groundwater Measurements

REFERENCES:

Smith, Mackey, 1975, *Preliminary Surficial Geologic Map of the Edmonds East and Edmonds West Quadrangles, Snohomish and King Counties, Washington.* U. S. Geological Survey. State of Washington Department of Natural Resources, Geologic Map GM-14, scale 1:24,000.

BNSF and Union Pacific, 2004, *Guidelines for Temporary Shoring*



HWA GEOSCIENCES INC.	VICINITY MAP	DRAWN BY EFK	FIGURE NO. 1
	WILLOW CREEK CULVERT REPLACEMENT UNDER BNSF MAINLINE EDMONDS, WASHINGTON	CHECK BY DM DATE 12.18.08	PROJECT NO. 2007-147-21

LEGEND

BH-1 BOREHOLE DESIGNATION AND APPROXIMATE LOCATION

BASE MAP IS FROM A PDF PROVIDED BY CLIENT

S:\2007 PROJECTS\2007-142-21 WILLOW CREEK CULVERT REPLACEMENT UNDER BNSF MAINLINE\CAD\HWA 2007-142.DWG

HWA GEOSCIENCES INC.	WILLOW CREEK CULVERT REPLACEMENT UNDER BNSF MAINLINE EDMONDS, WASHINGTON	SITE AND EXPLORATION PLAN	DRAWN BY EFK CHECK BY DM DATE 12.18.08	FIGURE NO. 2 PROJECT NO. 2007-142-21

RELATIVE DENSITY OR CONSISTENCY VERSUS SPT N-VALUE

COHESIONLESS SOILS			COHESIVE SOILS		
Density	N (blows/ft)	Approximate Relative Density(%)	Consistency	N (blows/ft)	Approximate Undrained Shear Strength (psf)
Very Loose	0 to 4	0 - 15	Very Soft	0 to 2	<250
Loose	4 to 10	15 - 35	Soft	2 to 4	250 - 500
Medium Dense	10 to 30	35 - 65	Medium Stiff	4 to 8	500 - 1000
Dense	30 to 50	65 - 85	Stiff	8 to 15	1000 - 2000
Very Dense	over 50	85 - 100	Very Stiff	15 to 30	2000 - 4000
			Hard	over 30	>4000

USCS SOIL CLASSIFICATION SYSTEM

MAJOR DIVISIONS			GROUP DESCRIPTIONS	
Coarse Grained Soils More than 50% Retained on No. 200 Sieve Size	Gravel and Gravelly Soils More than 50% of Coarse Fraction Retained on No. 4 Sieve	Clean Gravel (little or no fines)	GW	Well-graded GRAVEL
			GP	Poorly-graded GRAVEL
		Gravel with Fines (appreciable amount of fines)	GM	Silty GRAVEL
			GC	Clayey GRAVEL
	Sand and Sandy Soils 50% or More of Coarse Fraction Passing No. 4 Sieve	Clean Sand (little or no fines)	SW	Well-graded SAND
			SP	Poorly-graded SAND
		Sand with Fines (appreciable amount of fines)	SM	Silty SAND
			SC	Clayey SAND
Fine Grained Soils	Silt and Clay	Liquid Limit Less than 50%	ML	SILT
			CL	Lean CLAY
			OL	Organic SILT/Organic CLAY
50% or More Passing No. 200 Sieve Size	Silt and Clay	Liquid Limit 50% or More	MH	Elastic SILT
			CH	Fat CLAY
			OH	Organic SILT/Organic CLAY
Highly Organic Soils			PT	PEAT

TEST SYMBOLS

%F	Percent Fines
AL	Atterberg Limits: PL = Plastic Limit, LL = Liquid Limit
CBR	California Bearing Ratio
CN	Consolidation
DD	Dry Density (pcf)
DS	Direct Shear
GS	Grain Size Distribution
K	Permeability
MD	Moisture/Density Relationship (Proctor)
MR	Resilient Modulus
PID	Photoionization Device Reading
PP	Pocket Penetrometer Approx. Compressive Strength (tsf)
SG	Specific Gravity
TC	Triaxial Compression
TV	Torvane Approx. Shear Strength (tsf)
UC	Unconfined Compression

SAMPLE TYPE SYMBOLS

- 2.0" OD Split Spoon (SPT) (140 lb. hammer with 30 in. drop)
- Shelby Tube
- 3-1/4" OD Split Spoon with Brass Rings
- Small Bag Sample
- Large Bag (Bulk) Sample
- Core Run
- Non-standard Penetration Test (3.0" OD split spoon)

GROUNDWATER SYMBOLS

- ∇ Groundwater Level (measured at time of drilling)
- ▼ Groundwater Level (measured in well or open hole after water level stabilized)

COMPONENT DEFINITIONS

COMPONENT	SIZE RANGE
Boulders	Larger than 12 in
Cobbles	3 in to 12 in
Gravel	3 in to No 4 (4.5mm)
Coarse gravel	3 in to 3/4 in
Fine gravel	3/4 in to No 4 (4.5mm)
Sand	No. 4 (4.5 mm) to No. 200 (0.074 mm)
Coarse sand	No. 4 (4.5 mm) to No. 10 (2.0 mm)
Medium sand	No. 10 (2.0 mm) to No. 40 (0.42 mm)
Fine sand	No. 40 (0.42 mm) to No. 200 (0.074 mm)
Silt and Clay	Smaller than No. 200 (0.074mm)

COMPONENT PROPORTIONS

PROPORTION RANGE	DESCRIPTIVE TERMS
< 5%	Clean
5 - 12%	Slightly (Clayey, Silty, Sandy)
12 - 30%	Clayey, Silty, Sandy, Gravelly
30 - 50%	Very (Clayey, Silty, Sandy, Gravelly)

Components are arranged in order of increasing quantities.

MOISTURE CONTENT

DRY	Absence of moisture, dusty, dry to the touch.
MOIST	Damp but no visible water.
WET	Visible free water, usually soil is below water table.

NOTES: Soil classifications presented on exploration logs are based on visual and laboratory observation.
Soil descriptions are presented in the following general order:

Density/consistency, color, modifier (if any) GROUP NAME, additions to group name (if any), moisture content. Proportion, gradation, and angularity of constituents, additional comments. (GEOLOGIC INTERPRETATION)

Please refer to the discussion in the report text as well as the exploration logs for a more complete description of subsurface conditions.

HWA GEOSCIENCES INC.

WILLOW CREEK CULVERT REPLACEMENT
UNDER BNSF MAINLINE

LEGEND OF TERMS AND SYMBOLS USED ON EXPLORATION LOGS

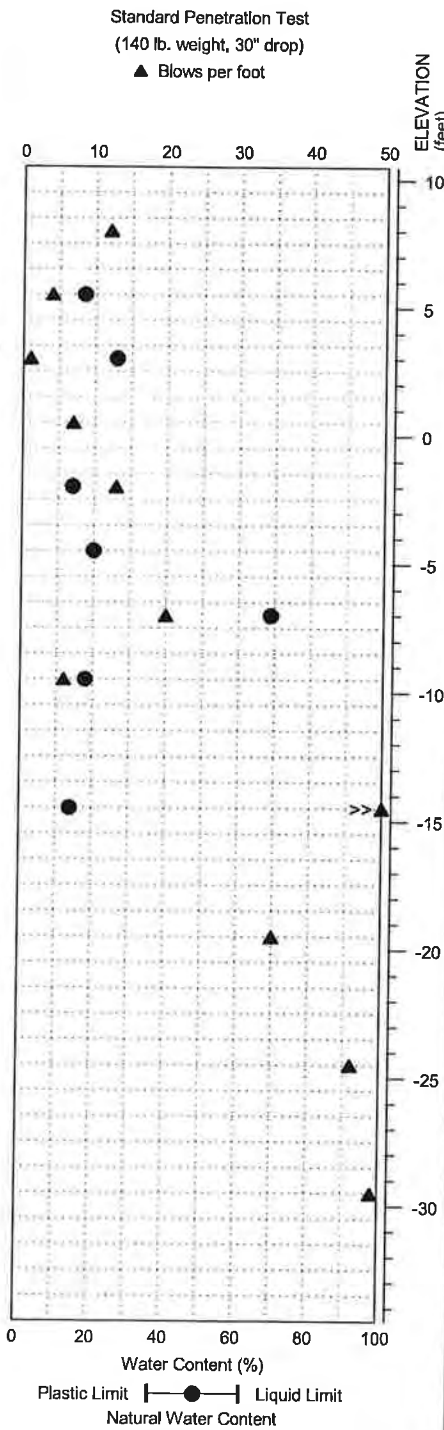
PROJECT NO.: 2007-147-21 FIGURE: 3

DRILLING COMPANY: Holocene Drilling
DRILLING METHOD: Hollow Stem Auger, CME-850 track mounted rig
SAMPLING METHOD: SPT with autohammer
LOCATION: See Figure 2: Site and Exploration Plan

DATE STARTED: 07/16/2008
DATE COMPLETED: 07/16/2008
LOGGED BY: J. Speck
SURFACE ELEVATION: 10.5 ± feet

DEPTH (feet)	USCS SOIL CLASS	DESCRIPTION	SAMPLE NUMBER	PEN. RESISTANCE (blows/6 inches)	OTHER TESTS
0	ML	Light brown, sandy SILT.			
	SP	Loose to medium dense, dark olive brown, gravelly, fine to medium SAND, moist.	S-1	3-5-7	
5			S-2	4-3-1	MC
	ML SM	Loose, dark olive brown, gravelly, fine to medium silty SAND to sandy SILT, wet.	S-3	0-0-1	MC
10			S-4	1-2-5	
	SM	Loose to medium dense, dark gray, fine to medium silty SAND, wet.	S-5	5-7-6	MC
15		8 inch heave noted, water added.	S-6	5-4-2	GS MC
	ML	Medium dense, dark olive brown, slightly gravelly, organic SILT, wet.	S-7	14-10-10	MC
20	SM	Dense, dark olive brown, slightly gravelly, fine to medium silty SAND, wet. Trace decomposed wood (black). 2 inch lense of sandy SILT at 20.25 feet.	S-8	6-2-4	GS MC
25		Some siltier lenses 4 inch thick at 25.25 feet, 2 inch thick at 26 feet.	S-9	15-29-36	GS MC
30	SP	Dense, dark gray, fine to medium SAND with trace fines and gravel, wet.	S-10	1-8-27	
35	SM	Dense, dark olive brown, silty fine to medium SAND with gravel, wet.	S-11	7-17 -29	
40			S-12	8-16 -33	
45		Borehole completed at TD = 41.5 feet. Groundwater noted at 7 feet during exploration.			

GROUNDWATER



NOTE: This log of subsurface conditions applies only at the specified location and on the date indicated and therefore may not necessarily be indicative of other times and/or locations.

HWA GEOSCIENCES INC.

WILLOW CREEK CULVERT REPLACEMENT
UNDER BNSF MAINLINE

BORING:
BH-1

PAGE: 1 of 1

PROJECT NO.: 2007-147-21 FIGURE: 4

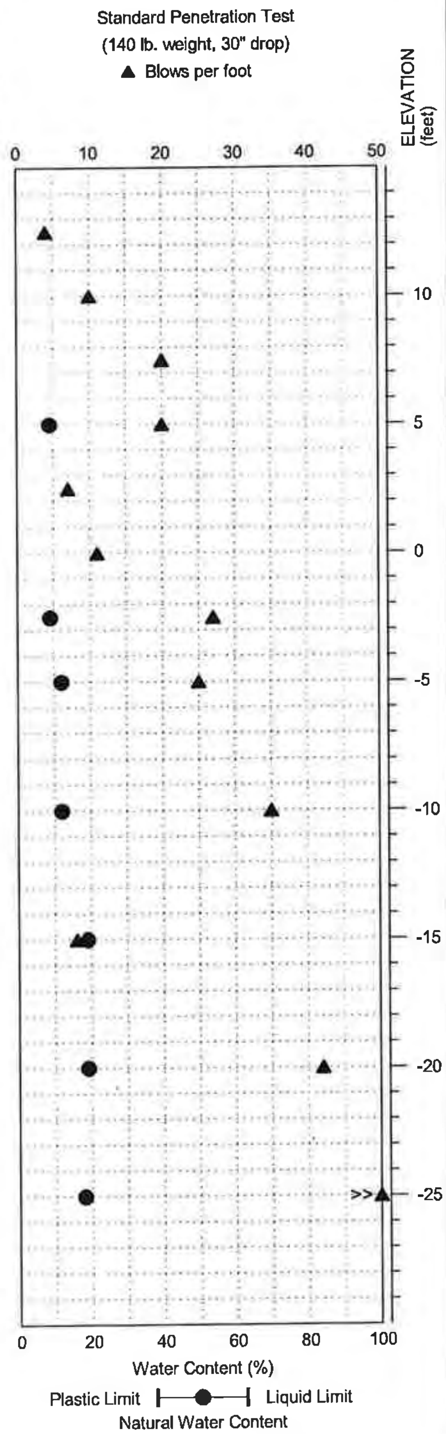
BORING-DSM 2007142.GPJ 2/26/10

DRILLING COMPANY: Holocene Drilling
DRILLING METHOD: Hollow Stem Auger, CME-850 track mounted rig
SAMPLING METHOD: SPT with autohammer
LOCATION: See Figure 2: Site and Exploration Plan

DATE STARTED: 07/17/2008
DATE COMPLETED: 07/17/2008
LOGGED BY: J. Speck/B. Blanchette
SURFACE ELEVATION: 15.0 ± feet

DEPTH (feet)	USCS SOIL CLASS	DESCRIPTION	SAMPLE NUMBER	PEN. RESISTANCE (blows/6 inches)	OTHER TESTS
0	SM	Cuttings, brown, sandy SILT to fine to medium silty SAND with gravel, moist.			
		No recovery	S-1	4-2-2	
5	SP	Medium dense, olive brown, gravelly, fine to coarse SAND, moist.	S-2	3-4-6	
			S-3	4-8-12	
10		Very gravelly, gravel is fine to coarse. Wet.	S-4	6-9-11	GS MC
			S-5	4-3-4	
15			S-6	2-6-5	
			S-7	8-13-14	MC
20	SP SM	Medium dense, olive brown, gravelly, fine to coarse slightly silty SAND, wet. Gravel is fine. Noticeably more fine sand than above sample.	S-8	11-10-15	GS MC
25	SM	Dense, dark gray, gravelly, fine to medium silty SAND, wet.	S-9	9-15-20	MC
30		Material becomes loose with a 3 inch thick silty sand lense at 31 feet. Color changes to dark gray at 31 feet. Wood fragments noted at 30.5 feet.	S-10	8-3-5	GS MC
35			S-11	13-21 -21	MC
40			S-12	31 -50/3	MC

Borehole completed at TD = 41.5 feet. Groundwater was first noted at 9.5 feet during exploration.



NOTE: This log of subsurface conditions applies only at the specified location and on the date indicated and therefore may not necessarily be indicative of other times and/or locations.

HWA GEOSCIENCES INC.

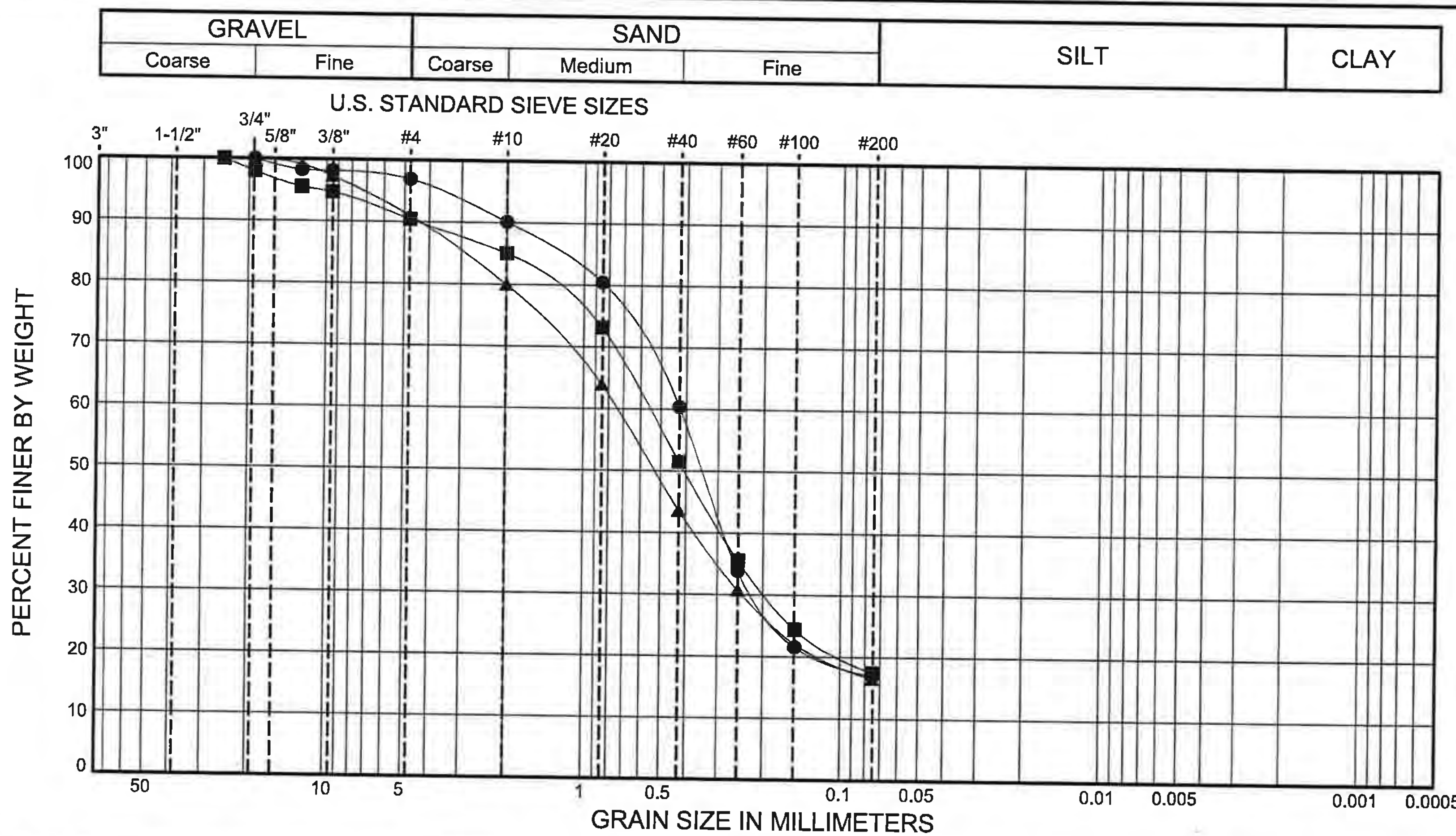
WILLOW CREEK CULVERT REPLACEMENT
UNDER BNSF MAINLINE

BORING:
BH-2

PAGE: 1 of 1

PROJECT NO.: 2007-147-21 FIGURE: 5

BORING-DSM 2007142.GPJ 2/26/10



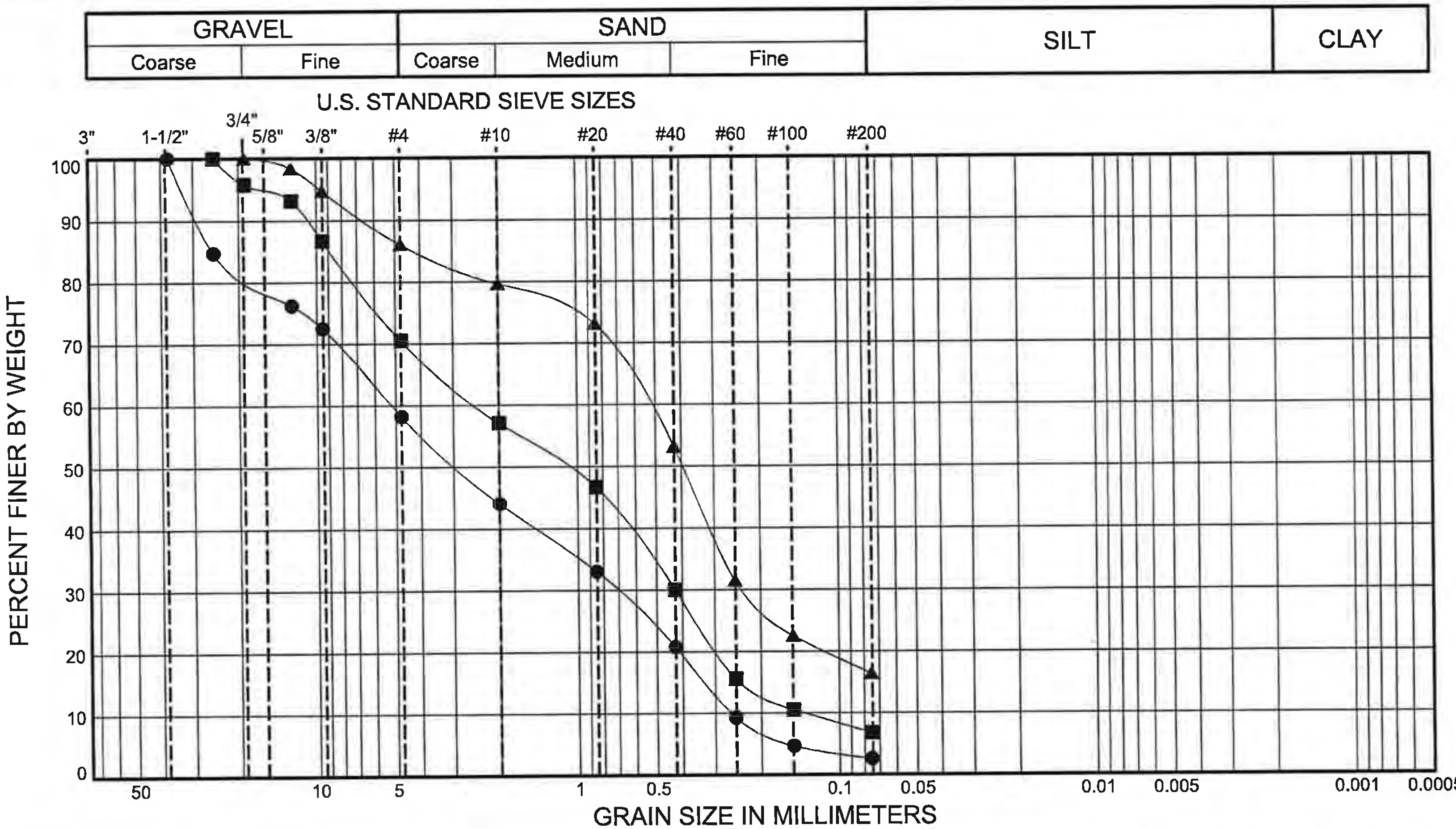
SYMBOL	SAMPLE		DEPTH (ft)	CLASSIFICATION OF SOIL- ASTM D2487 Group Symbol and Name	% MC	LL	PL	PI	Gravel %	Sand %	Fines %
●	BH-1	S-6	15.0 - 16.5	(SM) Dark gray, silty SAND	20				3.1	80.0	16.9
■	BH-1	S-8	20.0 - 21.5	(SM) Dark olive gray, silty SAND	18				9.6	73.0	17.5
▲	BH-1	S-9	25.0 - 26.5	(SM) Dark olive gray, silty SAND	14				9.0	74.5	16.5

HWA GEOSCIENCES INC.

WILLOW CREEK CULVERT REPLACEMENT
UNDER BNSF MAINLINE

PARTICLE-SIZE ANALYSIS
OF SOILS
METHOD ASTM D422

PROJECT NO.: 2007-147-21 FIGURE: 6



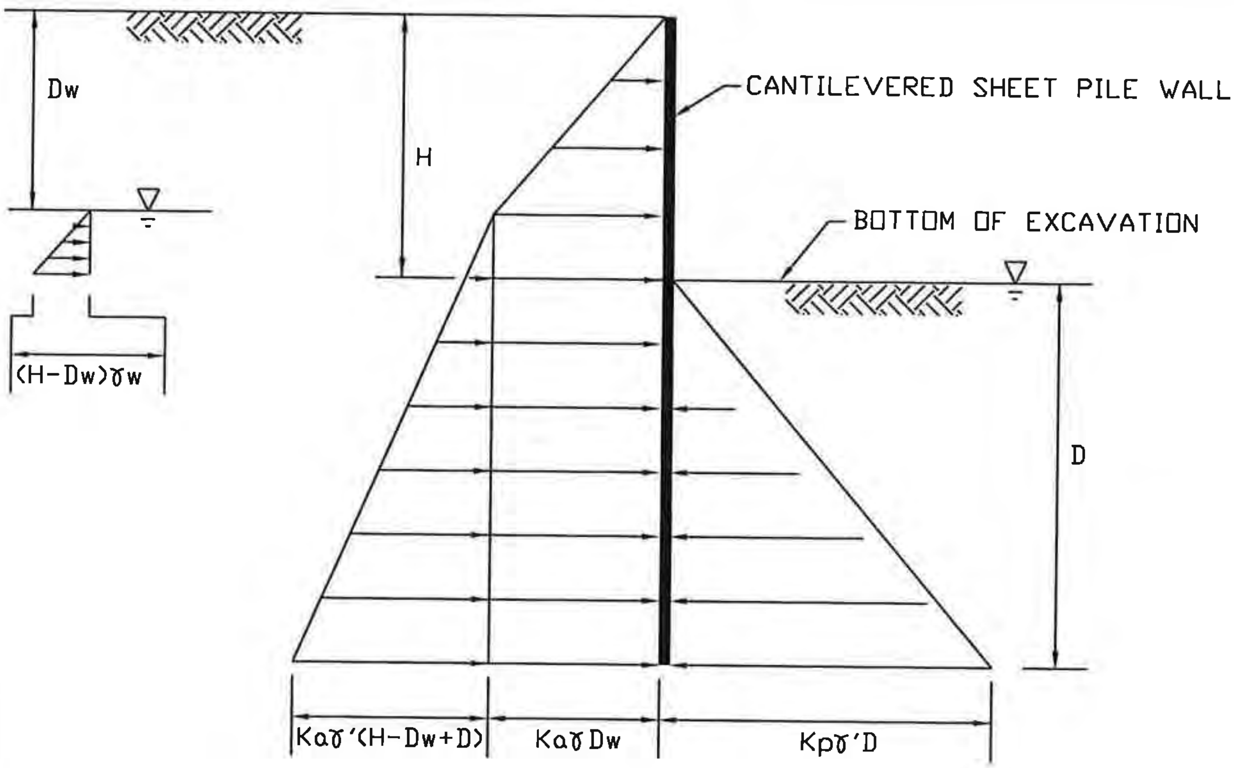
SYMBOL	SAMPLE		DEPTH (ft)	CLASSIFICATION OF SOIL- ASTM D2487 Group Symbol and Name	% MC	LL	PL	PI	Gravel %	Sand %	Fines %
●	BH-2	S-4	10.0 - 10.7	(SP) Grayish brown, poorly graded SAND with gravel	9				41.8	55.6	2.6
■	BH-2	S-8	20.0 - 20.7	(SP-SM) Dark olive gray, poorly graded SAND with silt and gravel	12				29.5	63.7	6.8
▲	BH-2	S-10	30.0 - 31.5	(SM) Dark gray, silty SAND	19				13.9	69.6	16.4

HWA GEOSCIENCES INC.

WILLOW CREEK CULVERT REPLACEMENT
UNDER BNSF MAINLINE

PARTICLE-SIZE ANALYSIS
OF SOILS
METHOD ASTM D422

PROJECT NO.: 2007-147-21 FIGURE: 7



Ka = 0.31 (ø = 32°) with level backfill

Kp = 3.25

γ = 115 pcf

γ' = 53 pcf

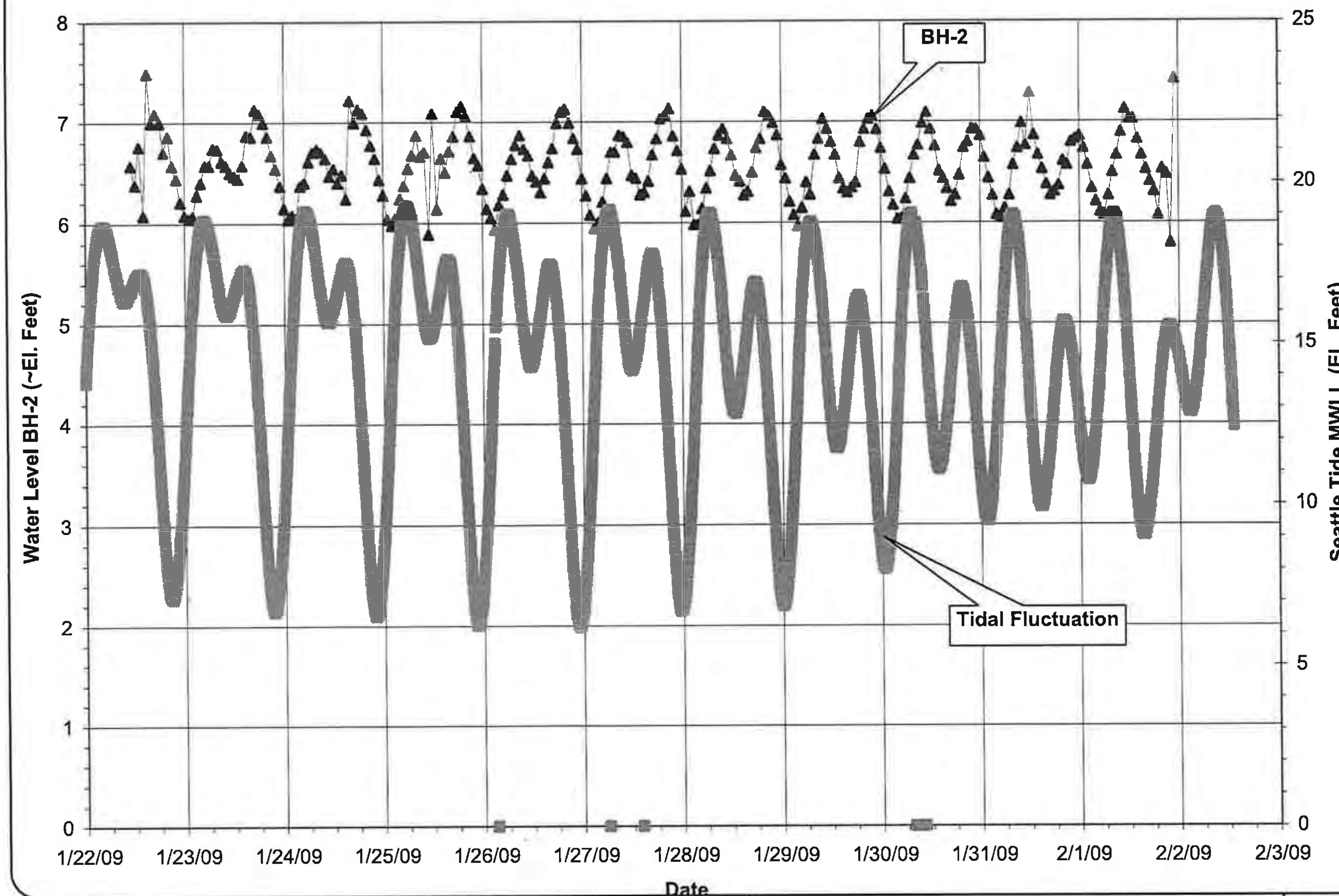
γ_w = 62.4 pcf

NOTES:

1. Assume interlocking steel sheets.
2. Ground water at elevation +7 feet.
3. Recommended lateral earth pressure values assume subsurface soils consist of medium dense soil.
4. The coeffients of active and passive pressure do not include the effects of wall friction.
5. Surcharge loads should be added to the active pressure where appropriate in accordance with BNSF Guideline for Temporary Shoring.

HWA GEOSCIENCES INC.

DESIGN EARTH PRESSURES FOR TEMPORARY CANTILEVER SHORING	DRAWN BY EFK	CHECKED BY DM	FIGURE NO. 8
WILLOW CREEK CULVERT REPLACEMENT UNDER BNSF MAINLINE EDMONDS, WASHINGTON	DATE 02.26.10		PROJECT NO. 2007-142.21



HWA GEOSCIENCES INC.

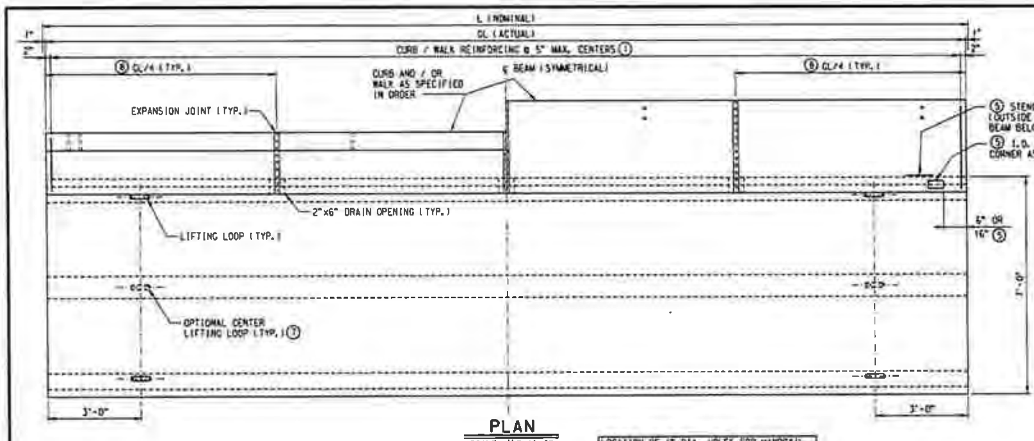
BH-2 WATER LEVEL FLUCTUATION

WILLOW CREEK CULVERT REPLACEMENT UNDER
BNSF MAINLINE
EDMONDS, WASHINGTON

FIGURE NO.
9

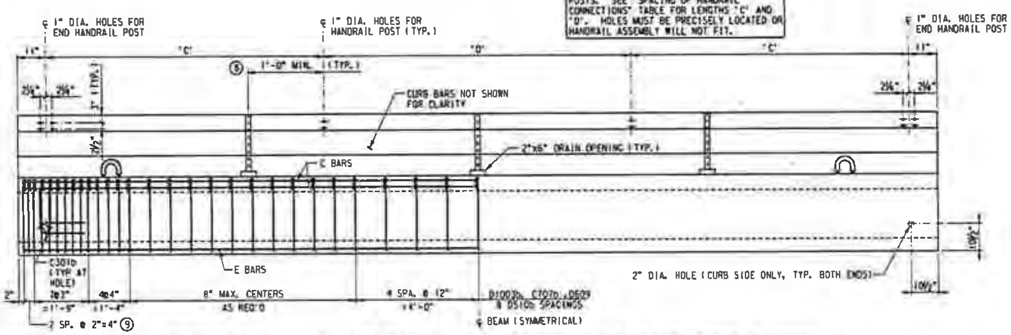
PROJECT NO.
2007-142-21

APPENDIX B
BNSF STANDARD EXHIBITS



PLAN

SCALE: 1/2" = 1'-0"

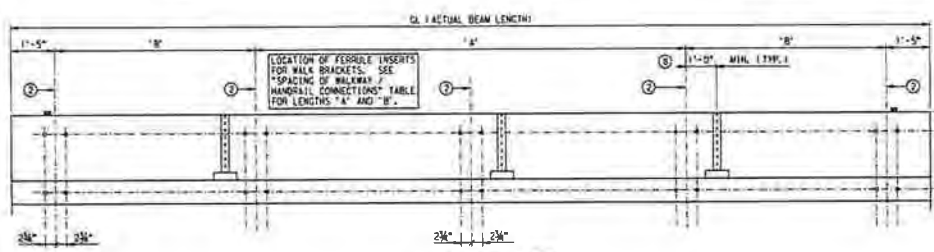


LOCATION OF 1" DIA. HOLES FOR HANDRAIL POSTS. SEE "SPACING OF HANDRAIL CONNECTIONS" TABLE FOR LENGTHS "C" AND "D". HOLES MUST BE PRECISELY LOCATED OR HANDRAIL ASSEMBLY WILL NOT FIT.

ELEVATION w/ CONVENTIONAL REINFORCING (SLOPED CURB SHOWN)

SCALE: 1/2" = 1'-0"

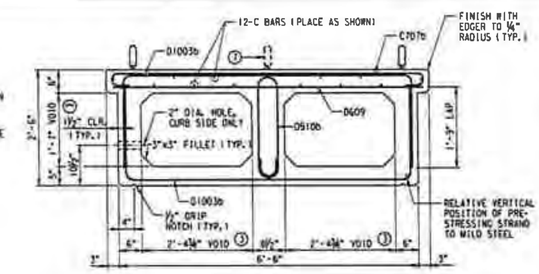
TYPE 1 BEAMS ONLY (FOR TYPE 2 SEE SHEET BG3)



LOCATION OF FERRULE INSERTS FOR WALK BRACKETS. SEE "SPACING OF WALKWAY / HANDRAIL CONNECTIONS" TABLE FOR LENGTHS "A" AND "B".

VIEW (A)

SCALE: 3/4" = 1'-0"



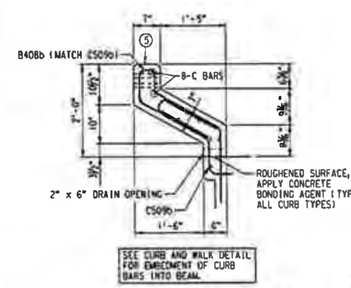
SECTION w/ CONVENTIONAL REINFORCING (w/o CURB)

SCALE: 3/4" = 1'-0"

(STRANDS NOT SHOWN)

SPACING OF WALKWAY / HANDRAIL CONNECTIONS				
ACTUAL BEAM LENGTH	FERRULE INSERTS		1" DIA. HOLES	
	"A"	"B"	"C"	"D"
19'-10"	84"	60"	9'-0"	N/A
20'-10"	84"	66"	9'-6"	N/A
21'-10"	84"	72"	10'-0"	N/A
22'-10"	84"	78"	5'-6"	10'-0"
23'-10"	84"	84"	6'-0"	10'-0"
24'-10"	2@84"	48"	6'-6"	10'-0"
25'-10"	2@84"	54"	7'-0"	10'-0"
26'-10"	2@84"	60"	7'-6"	10'-0"
27'-10"	2@84"	66"	8'-0"	10'-0"
28'-10"	2@84"	72"	8'-6"	10'-0"
29'-10"	2@84"	78"	9'-0"	10'-0"
30'-10"	2@84"	84"	9'-6"	10'-0"
31'-10"	3@84"	48"	10'-0"	10'-0"
32'-10"	3@84"	54"	5'-6"	2@10'-0"
33'-10"	3@84"	60"	6'-0"	2@10'-0"
34'-10"	3@84"	66"	6'-6"	2@10'-0"
35'-10"	3@84"	72"	7'-0"	2@10'-0"

For General Notes, see Sheet BG2.

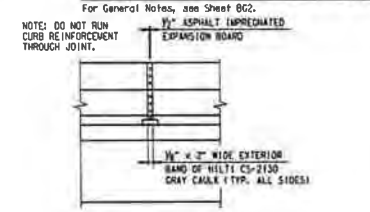


SEE CURB AND WALK DETAIL FOR EMBEDMENT OF CURB BARS INTO BEAM.

SLOPED CURB DETAIL

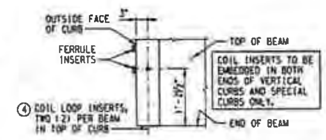
SCALE: 3/4" = 1'-0"

NOTE: DO NOT RUN CURB REINFORCEMENT THROUGH JOINT.



ELEVATION - CURB EXPANSION JOINT

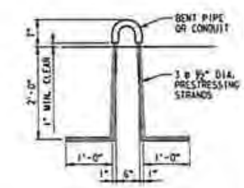
SCALE: 1/2" = 1'-0"



COIL INSERTS TO BE EMBEDDED IN BOTH ENDS OF VERTICAL CURBS AND SPECIAL CURBS ONLY.

VIEW (B)

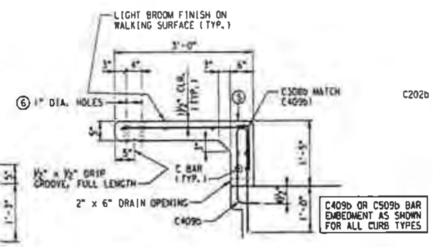
SCALE: 3/4" = 1'-0"



LIFTING LOOP DETAIL

SCALE: 3/4" = 1'-0"

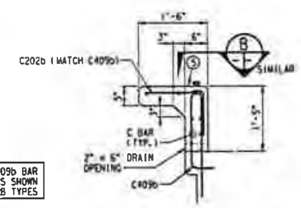
(FABRICATOR IS RESPONSIBLE FOR ADEQUACY OF LIFTING LOOPS, SEE NOTE SHEET BG2.)



C409b OR C509b BAR EMBEDMENT AS SHOWN FOR ALL CURB TYPES

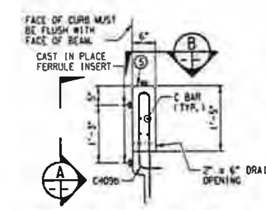
CURB AND WALK DETAIL

SCALE: 3/4" = 1'-0"



SPECIAL CURB DETAIL

SCALE: 3/4" = 1'-0"



VERTICAL CURB DETAIL

SCALE: 3/4" = 1'-0"

(1) Adjust as required to miss other reinforcement, ferrule inserts, handrail post holes, and curb expansion joints.

(2) Cast-in-place ferrule inserts, F-65, 5/8" dia. type LF as manufactured by Dayton/Richmond or equal. Minimum shear = 3,000 lb, minimum tension = 3,320 lb with a factor of safety of 3 to 1. 4 inserts per walk bracket location. Furnish with 5/8" dia. bolts and washers. All items shall be galvanized.

(3) Void dimensions shown are maximum and must not be exceeded at any point including splices of void form.

(4) Coil loop inserts are to be single flared type B-16, 1" dia. x 12" as manufactured by Dayton Superior, and have a safe working load of 4,750 lb. with a factor of safety of 4 to 1. The inserts are to be completely recessed with spiral bolts furnished in the insert.

(5) 3" x 6" I.D. Plate is to be embedded flush in top of curb and centered. Locate 6" from end of curb for curb and walk, special curb, or vertical curb; 16" from end for curb for sloped curb. Plate shall contain the following information in 1/2" lettering: Item name, length, number and diameter of prestressing strands, date manufactured, and name of manufacturer.

The same information, plus actual lifting weight, shall be clearly stenciled on the side of the beam.

(6) Two 1" dia. holes shall be located 17", 17"+A, 17"+2A, and 17"+3A from one end of beam. Holes must be in proper location or handrail will not fit. A = (GL - 34")/3.

(7) Optional center lifting loops (shown dashed) to be provided only if specified by purchasing railroad.

(8) Curb to be divided into four (4) equal segments as shown. If curb joints cannot be equally spaced due to conflicts with handrail connections, then fabricator shall adjust curb segment lengths so that each curb joint is a minimum of 12" from centerline of any walkway / handrail conection.

(9) Increase end stirrup group to 6 spaces at 2" = 1'-0" for L > 34'. All other spacings remain as shown.

BLOCKING NOTE:

BEAM SHALL BE SUPPORTED BY BLOCKING WITHIN 1'-6" OF ENDS DURING STORAGE AND TRANSPORT. STORE AND TRANSPORT BEAMS IN LEVEL POSITIONS.

FIELD NOTE

For beams located over roadways, the drain openings shall be covered with wire screen to prevent ballast from falling off beams. Screen shall be industrial wire screen meeting the requirements specified in ASTM E437-85, Heavy Grade, 1/4" opening, plain weave, galvanized sheet. Screen shall fully cover opening and be anchored into the concrete. Screen installation to be in field by Railroad forces or contractor.

REVISIONS		
DATE	LTR.	DESCRIPTION
8/03	A	CHANGE SIZE & SPACING OF CURB BAR
10/03	B	1" DIA. HOLES IN WALK (NOTE 6)
2/04	C	LIFTING LOOPS, STIRRUPS, I.D. PLATE
1/06	D	CURB REBARS
10/06	E	CURB REBARS & JOINT, OPTIONAL LOOP
12/07	F	STRAND PATTERNS, WEIGHTS, MISC.

DESIGN BY: MLM | DRAWN BY: DTP | CHECKED BY: MLM

APPROVED:

K.H. Jennison

BNSF - ASSISTANT DIRECTOR STRUCTURES DESIGN

George A. Meyer

UPRR - MGR SPECIAL PROJECTS STRUCTURES DESIGN

BNSF RAILWAY — UNION PACIFIC

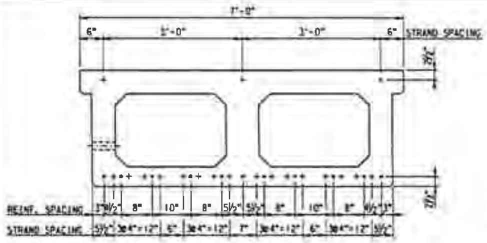
BRIDGE STANDARDS

CONCRETE BEAM BRIDGES

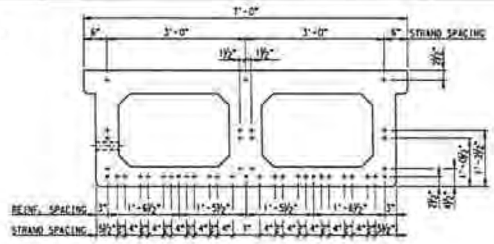
30"x7'-0" DOUBLE BOX BEAM
VARIOUS LENGTHS
FRAMING AND REINFORCING

FILE OWNER: UPRR | DATE: MAY 2003

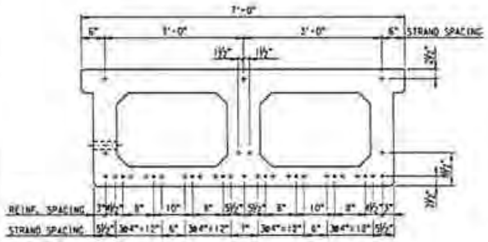
PLAN NO.: 500000 | SHEET: BG1



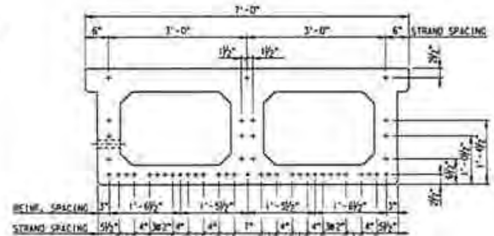
L = 20'-0" TO L = 22'-0"
+(19 - 0.6" 270 KSI STRANDS)
*(11 - #6 REINFORCING BAR)



L > 28'-0" TO L = 30'-0"
+(37 - 0.6" 270 KSI STRANDS)
*(5 - #6 REINFORCING BAR)

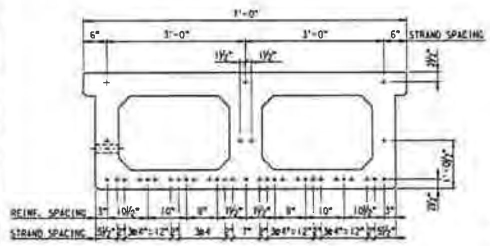


L > 22'-0" TO L = 24'-0"
+(23 - 0.6" 270 KSI STRANDS)
*(11 - #6 REINFORCING BAR)

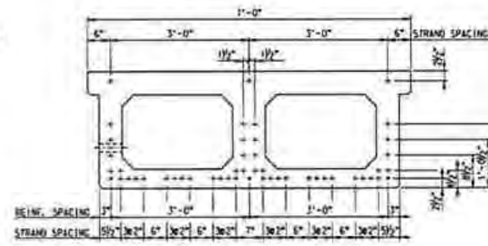


2 SP. @ 2" = 4"

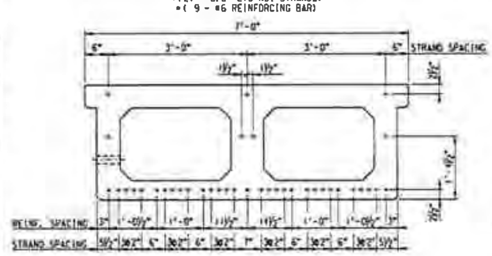
L > 30'-0" TO L = 32'-0"
+(41 - 0.6" 270 KSI STRANDS)
*(5 - #6 REINFORCING BAR)



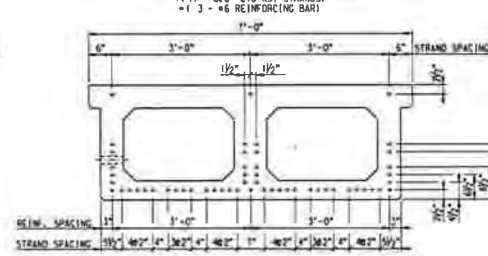
L > 24'-0" TO L = 26'-0"
+(27 - 0.6" 270 KSI STRANDS)
*(9 - #6 REINFORCING BAR)



L > 32'-0" TO L = 34'-0"
+(47 - 0.6" 270 KSI STRANDS)
*(3 - #6 REINFORCING BAR)



L > 26'-0" TO L = 28'-0"
+(31 - 0.6" 270 KSI STRANDS)
*(7 - #6 REINFORCING BAR)



L > 34'-0" TO L = 36'-0"
+(51 - 0.6" 270 KSI STRANDS)
*(3 - #6 REINFORCING BAR)

TYPE I 30" BOX BEAMS

SCALE: 3/4" = 1'-0"
(MAXIMUM LENGTHS ARE NOMINAL (L))

NOTE:
STRAND PATTERNS ARE TO BE USED ONLY FOR THE LENGTHS SHOWN. IF THE FABRICATOR, FOR CONVENIENCE, DESIRES TO USE A PATTERN SHOWN FOR A GREATER LENGTH., APPROVAL MUST BE OBTAINED FROM THE ENGINEER OF THE PURCHASING RAILROAD.

GENERAL NOTES

CONCRETE:

Concrete material, placing and curing shall be in accordance with the requirements specified in BNSF / UP Joint Specifications for Precast / Prestressed Concrete Products and the current edition of Chapter 8 of the AREMA Manual for Railway Engineering.

The compressive strength of the beam concrete shall be as specified in table below. The compressive strength of the curb concrete shall exceed 4000 psi at 28 days.

REQUIRED MINIMUM BEAM CONCRETE COMPRESSIVE STRENGTHS (PSI)

TYPE	LENGTH	AT TRANSFER	AT 28 DAYS
1	L ≤ 30	4,500	6,000
1	30 < L ≤ 34	5,000	7,000
1	L > 34	5,500	7,000
2	L ≤ 24	5,500	7,000
2	L > 24	6,000	8,500

Air entraining agents shall be in accordance with the requirements specified in the current edition of ASTM C260. The total entrained air content shall be 6% ± 1% by volume of the plastic concrete.

Concrete aggregate shall be in accordance with the requirements specified in the current edition of ASTM C33. Coarse aggregate shall be Size No. 67.

PRESTRESSING STRAND:

Prestressing strand shall be 0.6 inch diameter, seven wire, uncoated, low relaxation strand which is in accordance with the requirements specified in ASTM A416. The strand shall have an ultimate tensile strength of 270 ksi. The initial prestress shall be 43,400 lbs. per strand unless noted otherwise.

Strand shall be tested in accordance with PCI recommendations (Moustafa Method) and certified by the fabricator as having adequate bond characteristics to satisfy the prediction equations for transfer and development length given in the AREMA Manual for Railway Engineering.

An alternate strand pattern which has the same eccentricity as the pattern shown on this plan and is better suited to the manufacturer's facilities will be considered. Manufacturer must submit plans and computations for Railroad approval prior to casting.

REINFORCING STEEL:

Reinforcing steel shall be deformed, per current ASTM A615 Specification and meet grade 60 requirements, except bars crossing curb joint to be per current ASTM A1035 specification. Bars required to meet ASTM A1035 are noted in the Bending Diagrams.

Fabrication of reinforcing steel shall be per Chapter 7 of the CRSI Manual of Standard Practice. Dimensions of bending details are out to out of bar.

Reinforcing steel is to be blocked to proper location and securely wired against displacement. Use plastic protected reinforcing supports, meeting CRSI specifications Chapter 3, Class 1. Tack welding of reinforcing is prohibited. Minimum concrete cover on reinforcement shall meet current AREMA requirements.

DESIGN LOADS:

Dead Load (assumed - lb. per lin. ft. of track):

Track, fasteners, etc.	200
Ballast	4,065
Curb, Walk, & Handrail	560
Beams	2,825
Total	7,650

Live Load: Cooper E80; centrifugal force and effects of eccentricity and superelevation applied per provisions of AREMA Chapter 8. Design superelevation is 5" with 2" unbalance.

Impact: $\frac{225}{\sqrt{\ell}}$ % (where ℓ = L - 14")

Type 1 beams have been designed to accommodate a maximum offset between the centerline of track and the center of the longitudinal joint between beams of 6 inches. Type 1 beams shall be supplied with curb.

Type 2 beams have been designed to accommodate the placement of the track anywhere on the beam. Type 2 beams may be supplied with or without a curb.

MANUFACTURE:

Production procedures and dimensional tolerances for the manufacture of precast, prestressed beams shall be in accordance with the AREMA Manual for Railway Engineering and the Prestressed Concrete Institute's current Manual MNL 116 for Quality Control.

Tolerance for location of lifting loops shall be ±1/2".

The ends of the strands shall be burned off and recessed to a depth of 1 inch. Such recesses and minor spalls must be filled and finished to the plan dimensions using an epoxy bonding compound and grout.

Curb shall be cast after beam is removed from form.

Concrete bonding agent: refer to specifications.

Surfaces shall be formed in a manner which will produce a smooth and uniform appearance without rubbing or plastering. Unless otherwise noted, exposed edges of 90-degrees or less are to be chamfered 3/4" x 3/4". Unformed surfaces shall have a smooth finish free of all float and trowel marks.

The fabricator shall stencil the fabricator's name, date of fabrication, piece mark, and actual lifting weight at location shown.

The area around lifting loops shall not be recessed. Lifting loops to be removed in field flush with concrete surface.

Inspection, loading, and securing for shipment: refer to specifications.

If lifted with slings instead of lifting loops, slings must not be placed more than 3'-0" from ends of beams.

For intermediate beam lengths (not shown in "Spacing of Handrail Connections" table):

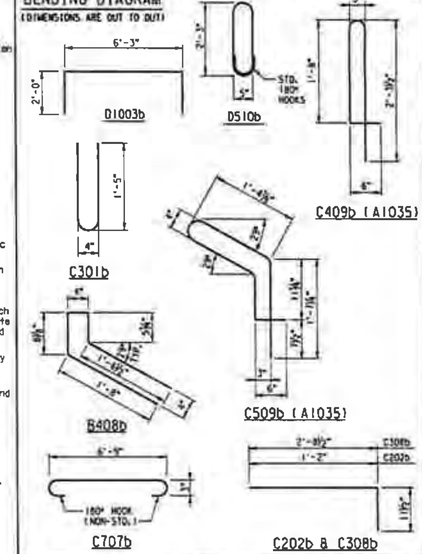
Vertical Curb - Length 'A' shall be held constant and length 'B' shall be adjusted.

Sloped Curb - Length 'D' shall be held constant and length 'C' shall be adjusted.

LIFTING LOOPS:

Fabricator is responsible for developing lifting loop anchorage detail to provide safety factor of 4 on working load. Detail shall be proof-tested with test results kept on file by fabricator and available for inspection by the railroad.

BENDING DIAGRAM
(DIMENSIONS ARE OUT TO OUT)



BAR DESIGNATIONS CONSIST OF BAR SIZE AND LENGTH FOLLOWED BY THE LETTER "b" IF BENT. BAR SIZES ARE REPRESENTED BY THE LETTERS A THROUGH L CORRESPONDING TO BAR NUMBERS 2 THROUGH 18. BAR LENGTHS ARE GIVEN IN FEET AND INCHES WITH THE FIRST DIGIT(S) INDICATING FEET AND THE LAST TWO DIGITS INDICATING INCHES.

LETTER	SIZE #
B	3
C	4
D	5
E	6

NOMINAL WEIGHT * (ONE BEAM)

NOMINAL BEAM LENGTH (L)	WEIGHT (WITH CURB AND WALK) LB.	TONS	WEIGHT (WITH SLOPED CURB) LB.	TONS	WEIGHT (WITH SPECIAL CURB) LB.	TONS	WEIGHT (WITH VERT. CURB) LB.	TONS	WEIGHT (NO CURB) LB.	TONS
PER FT	1,685	0.85	1,665	0.84	1,595	0.80	1,525	0.77	1,495	0.75
16'	26,800	13.4	26,400	13.2	25,300	12.7	24,300	12.2	23,200	11.6
17'	28,500	14.3	28,100	14.1	26,900	13.5	25,800	12.9	24,600	12.3
18'	30,100	15.1	29,700	14.9	28,400	14.2	27,200	13.6	25,900	13.0
19'	31,800	15.9	31,400	15.7	30,000	15.0	28,800	14.4	27,300	13.7
20'	33,400	16.7	33,000	16.5	31,600	15.8	30,300	15.2	28,700	14.4
21'	35,100	17.6	34,700	17.4	33,200	16.6	31,800	15.9	30,100	15.1
22'	36,900	18.4	36,300	18.2	34,700	17.4	33,300	16.7	31,500	15.8
23'	38,500	19.3	38,000	19.0	36,400	18.2	34,800	17.4	32,900	16.5
24'	40,200	20.1	39,600	19.8	38,000	19.0	36,300	18.2	34,400	17.2
25'	41,800	20.9	41,300	20.7	39,500	19.8	37,900	19.0	35,800	17.9
26'	43,500	21.8	42,900	21.5	41,100	20.6	39,300	19.7	37,100	18.6
27'	45,100	22.6	44,600	22.3	42,700	21.4	40,900	20.5	38,600	19.3
28'	46,800	23.4	46,200	23.1	44,300	22.2	42,400	21.2	40,000	20.0
29'	48,500	24.3	47,900	24.0	45,900	23.0	43,900	22.0	41,400	20.7
30'	50,200	25.1	49,500	24.8	47,400	23.7	45,400	22.7	42,700	21.4
31'	51,900	26.0	51,200	25.6	49,100	24.6	47,000	23.5	N/A	N/A
32'	53,600	26.8	52,900	26.5	50,700	25.4	48,500	24.3	N/A	N/A
33'	55,300	27.7	54,600	27.3	52,300	26.2	50,100	25.1	N/A	N/A
34'	56,900	28.5	56,200	28.1	53,800	26.9	51,500	25.8	N/A	N/A
35'	58,900	29.5	58,100	29.1	55,700	27.9	53,300	26.7	N/A	N/A
36'	60,600	30.3	59,800	29.9	57,300	28.7	54,800	27.4	N/A	N/A

* Computed weights using nominal dimensions. For planning purposes only. Fabricator to determine actual lifting weight (see Note 5 on Sheet BG1). If scale weight not available, use maximum weights on Sheet BG3.

REVISIONS		
DATE	LTR.	DESCRIPTION
6/03	A	CHANGE SIZE OF CURB BARS
10/03	B	ADD WT. SPECIAL & VERTICAL CURBS
2/04	C	CHANGE MIN. SPAN LENGTH TO 20'
10/06	D	CURB REBARS
10/06	E	MIN. SPAN = 16', CURB REBARS
12/07	F	STRAND PATTERNS, WEIGHTS, MISC.

DESIGN BY: MLM | DRAWN BY: DTP | CHECKED BY: MLM

APPROVED:

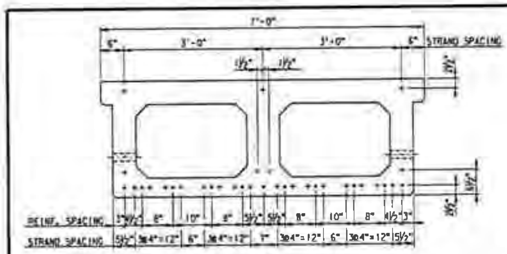
K.H. Jennison
BNSF - ASSISTANT DIRECTOR STRUCTURES DESIGN

Geo. J. Mun
UPRR - MOR SPECIAL PROJECTS STRUCTURES DESIGN

BNSF RAILWAY — UNION PACIFIC

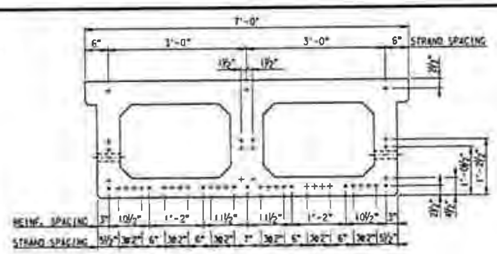
BRIDGE STANDARDS
CONCRETE BEAM BRIDGES
30"x7'-0" DOUBLE BOX BEAM NOTES, REBAR DETAILS, TYPE 1 STRAND PATTERNS

FILE OWNER: UPPR | DATE: MAY 2003
PLAN NO.: 500000 | SHEET: BG2



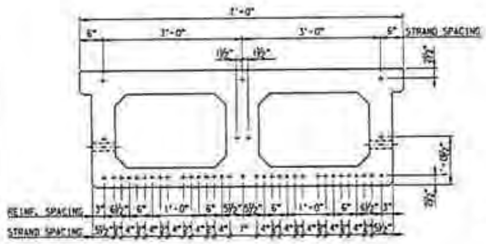
L = 20'-0" TO 22'-0"

+(23 - 0.6" 270 KSI STRANDS)
*(11 - #6 REINFORCING BAR)



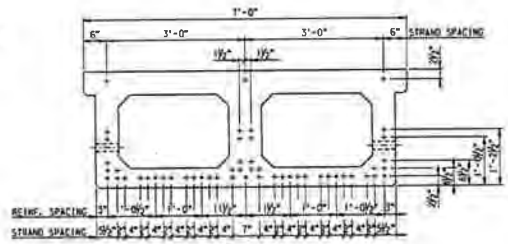
L > 26 '-0" TO 28'-0"

+(39 - 0.6" 270 KSI STRANDS)
*(7 - #6 REINFORCING BAR)



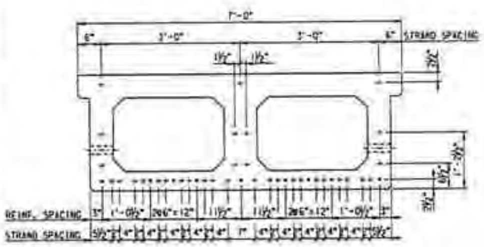
L > 22'-0" TO 24'-0"

+(29 - 0.6" 270 KSI STRANDS)
*(11 - #6 REINFORCING BAR)



L > 28 '-0" TO 30'-0"

+(45 - 0.6" 270 KSI STRANDS)
*(7 - #6 REINFORCING BAR)

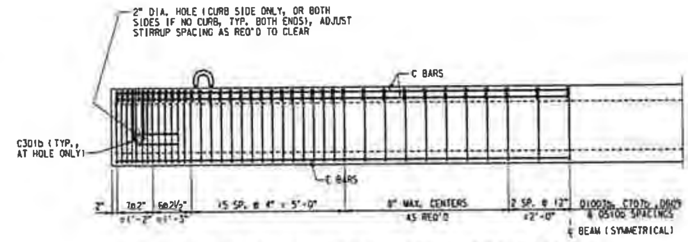


L > 24 '-0" TO 26'-0"

+(33 - 0.6" 270 KSI STRANDS)
*(9 - #6 REINFORCING BAR)

TYPE 2 30" BOX BEAMS

SCALE: 3/4" = 1'-0"
(MAXIMUM LENGTHS ARE NOMINAL (L))



ELEVATION w/ CONVENTIONAL REINFORCING

SCALE: 1/2" = 1'-0"
TYPE 2 BEAMS ONLY (FOR TYPE 1 SEE SHEET BG1)

NOTE:
STRAND PATTERNS ARE TO BE USED ONLY FOR THE LENGTHS SHOWN. IF THE FABRICATOR, FOR CONVENIENCE, DESIRES TO USE A PATTERN SHOWN FOR A GREATER LENGTH, APPROVAL MUST BE OBTAINED FROM THE ENGINEER OF THE PURCHASING RAILROAD.

MAXIMUM LIFTING WEIGHT * (ONE BEAM)

NOMINAL BEAM LENGTH (L)	WEIGHT (WITH CURB AND WALK)		WEIGHT (WITH SLOPED CURB)		WEIGHT (WITH SPECIAL CURB)		WEIGHT (WITH VERT. CURB)		WEIGHT (NO CURB)	
	LB.	TONS	LB.	TONS	LB.	TONS	LB.	TONS	LB.	TONS
PER FT	1,780	0.89	1,755	0.88	1,685	0.85	1,610	0.81	1,580	0.79
16'	28,300	14.2	27,900	14.0	26,800	13.4	25,700	12.9	24,500	12.3
17'	30,100	15.1	29,700	14.9	28,500	14.3	27,300	13.7	26,000	13.0
18'	31,800	15.9	31,400	15.7	30,100	15.1	28,800	14.4	27,400	13.7
19'	33,600	16.8	33,100	16.6	31,800	15.9	30,400	15.2	28,900	14.5
20'	35,300	17.7	34,900	17.5	33,400	16.7	32,000	16.0	30,300	15.2
21'	37,100	18.6	36,600	18.3	35,100	17.6	33,600	16.8	31,800	15.9
22'	38,800	19.4	38,300	19.2	36,700	18.4	35,200	17.6	33,300	16.7
23'	40,700	20.4	40,100	20.1	38,400	19.2	36,800	18.4	34,800	17.4
24'	42,400	21.2	41,900	21.0	40,100	20.1	38,400	19.2	36,300	18.2
25'	44,200	22.1	43,600	21.8	41,800	20.9	40,000	20.0	37,800	18.9
26'	45,900	23.0	45,300	22.7	43,400	21.7	41,600	20.8	39,200	19.6
27'	47,700	23.9	47,100	23.6	45,100	22.6	43,200	21.6	40,800	20.4
28'	49,500	24.8	48,800	24.4	46,800	23.4	44,800	22.4	42,300	21.2
29'	51,300	25.7	50,600	25.3	48,500	24.3	46,400	23.2	43,700	21.9
30'	53,000	26.5	52,300	26.2	50,100	25.1	48,000	24.0	45,200	22.6
31'	54,800	27.4	54,100	27.1	51,900	26.0	49,700	24.9	N/A	N/A
32'	56,600	28.3	55,900	28.0	53,500	26.8	51,300	25.7	N/A	N/A
33'	58,400	29.2	57,700	28.9	55,300	27.7	52,900	26.5	N/A	N/A
34'	60,200	30.1	59,400	29.7	56,900	28.5	54,500	27.3	N/A	N/A
35'	62,200	31.1	61,400	30.7	58,800	29.4	56,300	28.2	N/A	N/A
36'	64,000	32.0	63,100	31.6	60,500	30.3	57,900	29.0	N/A	N/A

* Computed weights using maximum dimensions per allowable tolerances. Use for lifting weight if scale weight is not available.

REVISIONS		
DATE	LTR.	DESCRIPTION
2/04	A	CHANGE MIN. SPAN LENGTH TO 20'
10/06	B	CHANGE MIN. SPAN LENGTH TO 16'
5/07	C	ELIMINATE MIN. SPAN LENGTH
12/07	F	STRAND PATTERNS, AREMA 2006 IMPACT
/		
/		

DESIGN BY: MLM | DRAWN BY: DTP | CHECKED BY: MLM

APPROVED:

K.H. Jennison
BNSF - ASSISTANT DIRECTOR STRUCTURES DESIGN

George A. Meyer
UPRR - MGR SPECIAL PROJECTS STRUCTURES DESIGN

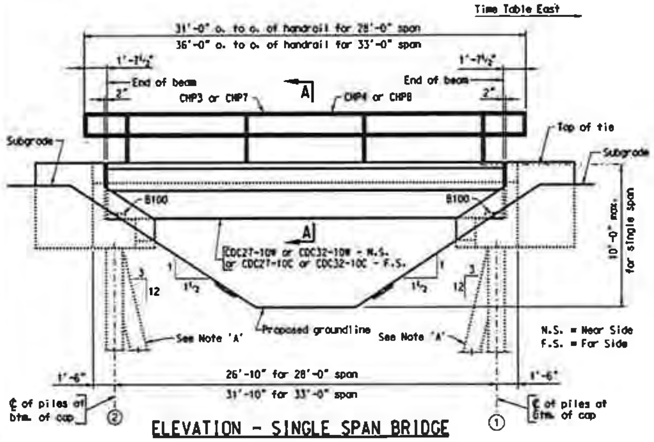
BNSF RAILWAY
UNION PACIFIC

BRIDGE STANDARDS

CONCRETE BEAM BRIDGES

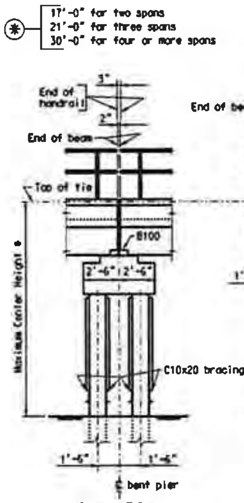
30"x7'-0" DOUBLE BOX BEAM TYPE 2 REINFORCING AND STRAND PATTERNS

FILE OWNER: UPPR | DATE: MAY 2003
PLAN NO.: 500000 | SHEET: 503

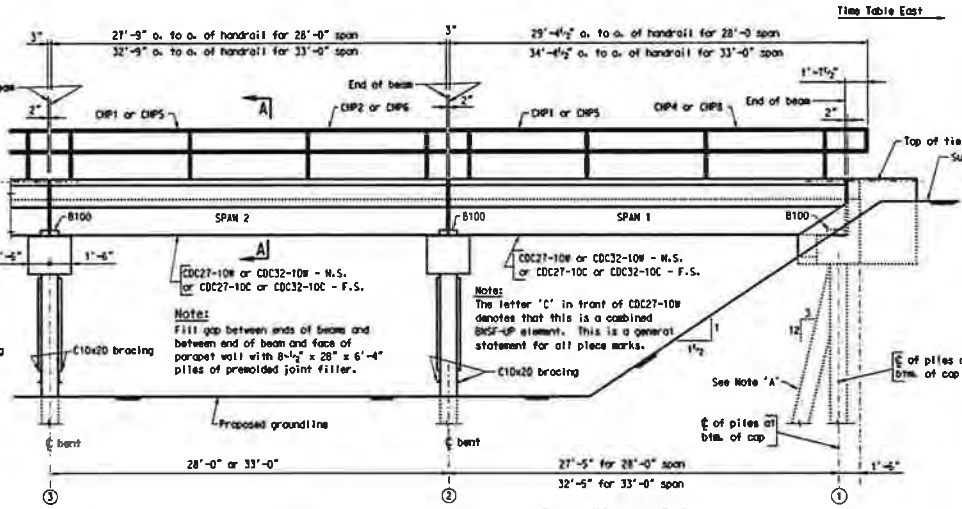


ELEVATION - SINGLE SPAN BRIDGE

Where walk and handrail are not required, substitute CDC27-10C for CDC27-10W and CDC32-10C for CDC32-10W.
See Section "A-A" on Sheet 2 of 24.



ELEVATION
DOUBLE BENT PIER



ELEVATION - INTERIOR SPAN

ELEVATION - END SPAN

Where walk and handrail are not required, substitute CDC27-10C for CDC27-10W and CDC32-10C for CDC32-10W.
See Section "A-A" on Sheet 2 of 24.

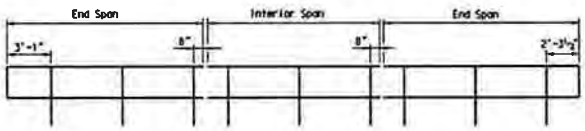
Note 'A':
When necessary to clear an existing pile, piles battered in the direction of the track may also be battered slightly in the direction normal to the track.

Double Bent Pier Requirements	
Lineal feet of Bridge	Min. No of Dbl. Bents Req'd.
up to 198'-0"	None
199'-0" to 396'-0"	One
397'-0" to 594'-0"	Two
595'-0" to 792'-0"	Three

MAXIMUM LIFTING WEIGHTS

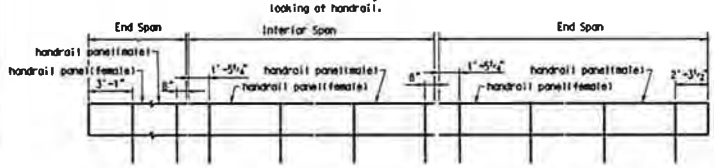
CDC27-10C = 44,800 LBS.
CDC27-10EC = 46,800 LBS.
CDC27-10SL = 48,800 LBS.
CDC27-10W = 49,500 LBS.
CDC32-10C = 52,900 LBS.
CDC32-10EC = 55,300 LBS.
CDC32-10SL = 57,700 LBS.
CDC32-10W = 58,400 LBS.

See BNSF-UP Plan Number 500000, Sheet Numbers BG1, BG2 and BG3 for details of 30 inch deep prestressed concrete double box beams.



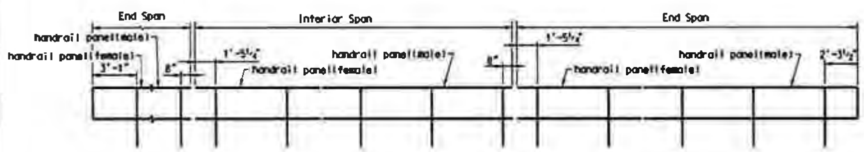
HANDRAIL PANEL LAYOUT DETAIL FOR SLOPED CURBS ONLY

Use where maximum span length = 21'-10".
See Sheet 22 of 24 for handrail details.
View taken standing outside of beam looking at handrail.



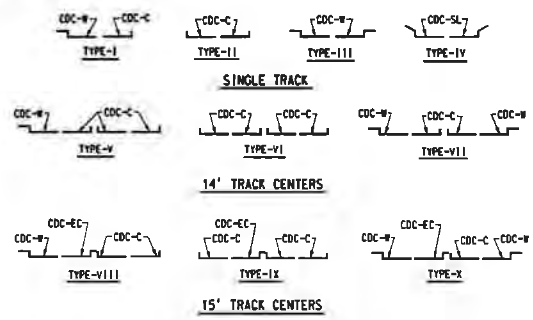
HANDRAIL PANEL LAYOUT DETAIL FOR SLOPED CURBS ONLY

Use for spans between lengths 21'-11" and 31'-10".
See Sheets 22 and 23 of 24 for handrail details.
View taken standing outside of beam looking at handrail.



HANDRAIL PANEL LAYOUT DETAIL FOR SLOPED CURBS ONLY

Use for spans between lengths 31'-11" and 34'-0".
See Sheet 23 of 24 for handrail details.
View taken standing outside of beam looking at handrail.



BEAM ARRANGEMENT DIAGRAMS

CDC-C denotes combined BNSF-UP beam with curb.
CDC-EC denotes combined BNSF-UP beam with extended curb.
* CDC-SL denotes combined BNSF-UP beam with sloped curb.
CDC-W denotes combined BNSF-UP beam with curb and walk.

* Sloped curbs will be utilized solely with single track construction

LIST OF DRAWINGS

SHEET NO.	TITLE
1	GENERAL PLAN
2 & 3	MISCELLANEOUS SECTIONS
4 & 5	SINGLE TRACK, SINGLE BENT - 'H' PILES
6	SINGLE TRACK, DOUBLE BENT - 'H' PILES
7 & 8	14' TRACK CENTERS, SINGLE BENT - 'H' PILES
9	14' TRACK CENTERS, DOUBLE BENT - 'H' PILES
10 & 11	15' TRACK CENTERS, SINGLE BENT - 'H' PILES
12	15' TRACK CENTERS, DOUBLE BENT - 'H' PILES
13	MISCELLANEOUS DETAILS
14, 15, 16, 17 & 18	PRECAST CONCRETE MEMBERS
19 & 20	STEEL DETAILS
21, 22 & 23	HANDRAIL PANEL DETAILS
24	GENERAL NOTES

Work Sheets 1, 2 and 3 of 24 together.

REVISIONS			
DATE	LTR	DESCRIPTION	
			DES: RU
			DRAWN: RU/VVT
			CHECK: RGB
			DATE: SEPT. 2009

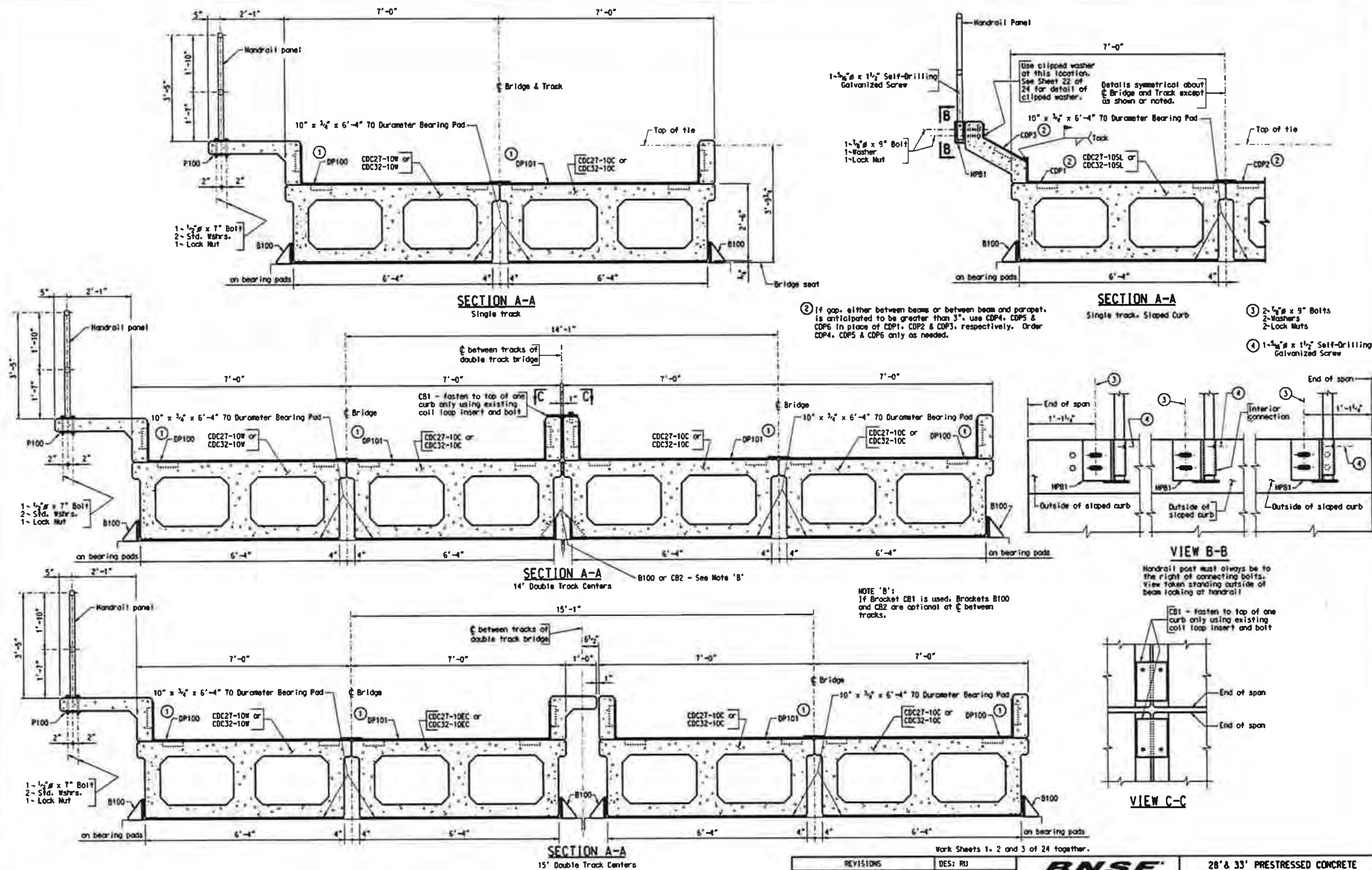
BNSF RAILWAY
BRIDGE ENGINEERING KANSAS CITY, KS
APPROVED:
ASST. DIRECTOR STRUCTURES DESIGN

28' & 33' PRESTRESSED CONCRETE SPANS - BNSF/UP COMMON BEAM

GENERAL PLAN

PLAN NO: 0000-17902-076

SHEET: 1 of 24



① If gap, either between beams or between beam and parapet, is anticipated to be greater than 3", use DP104 & DP105 in place of DP100 & DP101, respectively. Order DP104 & DP105 only as needed.

② If gap, either between beams or between beam and parapet, is anticipated to be greater than 3", use CDP4, CDP5 & CDP6 in place of CDP1, CDP2 & CDP3, respectively. Order CDP4, CDP5 & CDP6 only as needed.

③ 2-7/8"ø x 9" Bolts
2-Washers
2-Lock Nuts

④ 1-5/16"ø x 1 1/2" Self-Drilling Galvanized Screw

NOTE 'B':
If Bracket CB1 is used, Brackets B100 and CB2 are optional at ℄ between tracks.

Work Sheets 1, 2 and 3 of 24 together.

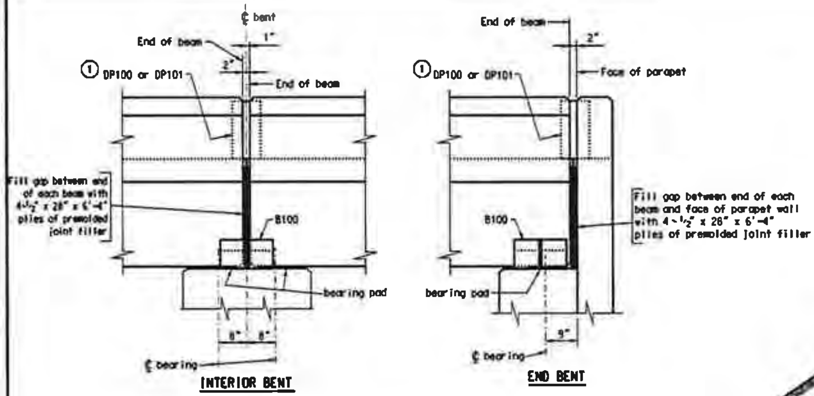
REVISIONS			
DATE	LTR	DESCRIPTION	DES: RU
			DRAWN: RU/VVT
			CHECK: RGB
			DATE: SEPT. 2009

BNSF RAILWAY
BRIDGE ENGINEERING, KANSAS CITY, KS
APPROVED:
ASST. DIRECTOR STRUCTURES DESIGN

28' & 33' PRESTRESSED CONCRETE SPANS - BNSF/UP COMMON BEAM

MISCELLANEOUS DETAILS

PLAN NO: 0000-17902-077
SHEET: 2 of 24



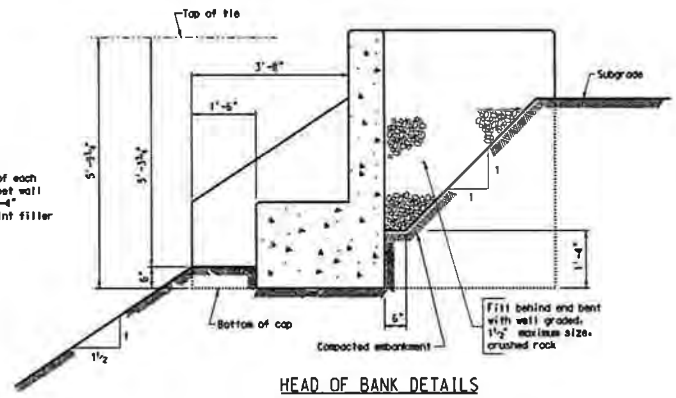
INTERIOR BENT

END BENT

BEARING DETAILS

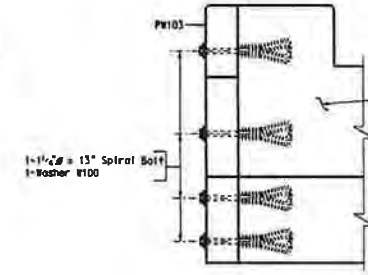
Handrails & wingwalls are not shown

① If gap, either between beams or between beam and parapet, is anticipated to be greater than 3", use DP104 & DP105 in place of DP100 & DP101, respectively. Order DP104 & DP105 only as needed.

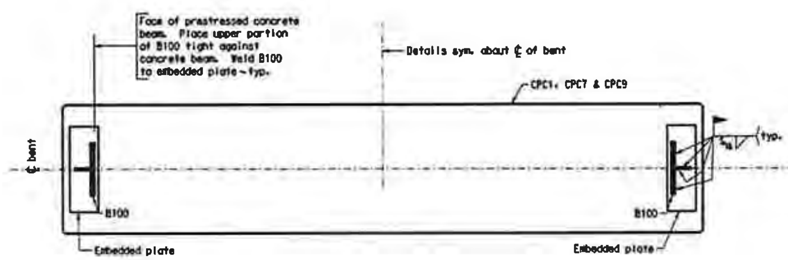


HEAD OF BANK DETAILS

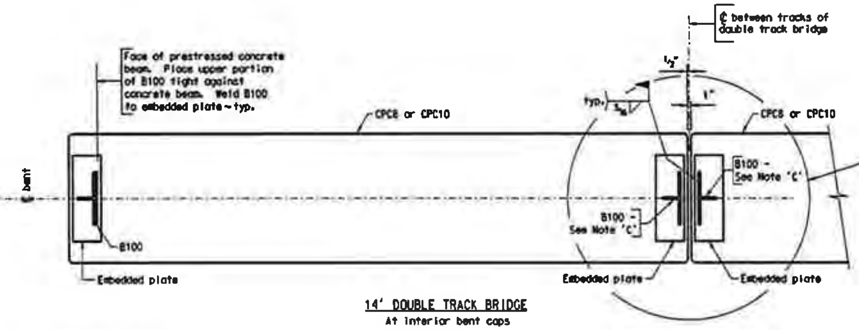
Before backfilling end bents, apply a coating of petrolatum to pile plates and top one foot of piles.



WING WALL TO END CAP DETAIL

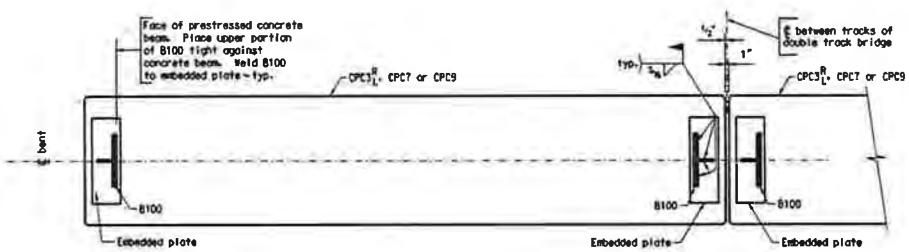


SINGLE TRACK BRIDGE

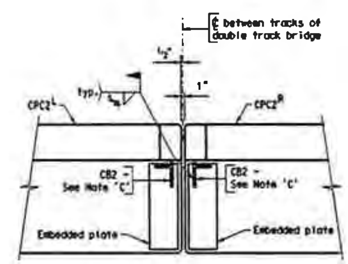


14' DOUBLE TRACK BRIDGE

At interior bent caps



15' DOUBLE TRACK BRIDGE



14' DOUBLE TRACK BRIDGE

At end bent caps

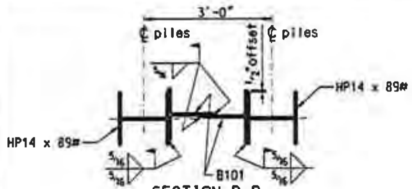
NOTE 'C':
Brackets B100 and CB2 at ℄ between tracks will need to be welded into position prior to setting spans for 14' Double Track Bridge.
Also see Note 'B' on Sheet 2 of 24.

WELDING OF LATERAL RESTRAINTS B100 & CB2

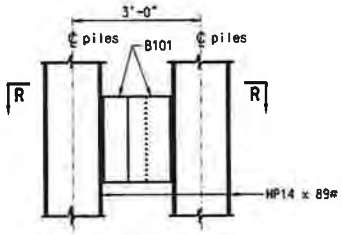
Plan view of caps shown

Work Sheets 1, 2 and 3 of 24 together.

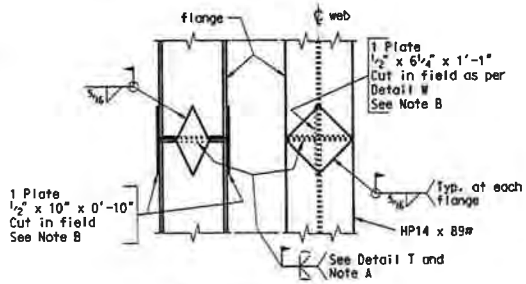
REVISIONS					
DATE	LTR	DESCRIPTION	DES: RU	BNSF RAILWAY	28' & 33' PRESTRESSED CONCRETE SPANS - BNSF/UP COMMON BEAM
			DRAWN: RU/VVT	BRIDGE ENGINEERING, KANSAS CITY, KS	
			CHECK: RGB	APPROVED:	MISCELLANEOUS DETAILS
			DATE: SEPT. 2009	ASST. DIRECTOR STRUCTURES DESIGN	PLAN NO: 0000-17902-0TB · SHEET: 3 of 24



SECTION R-R
Double bent pier

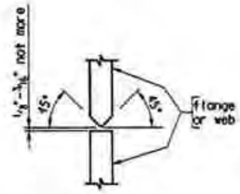


VIEW S-S
Side view of double bent pier
Cross bracing is not shown

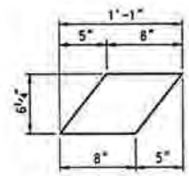


ALTERNATE PILE SPLICE 1

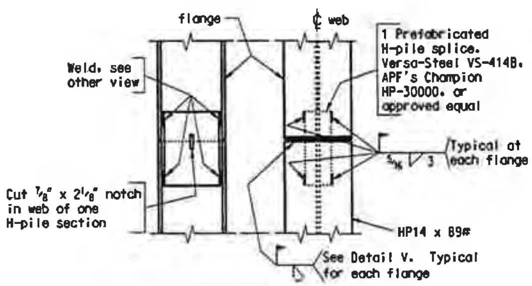
NOTE A: Before reinforcing plates are installed, grind the weld contours which will be covered by the reinforcing plates.
NOTE B: Reinforcing plates are required when pile splice is within 15 feet of the finished groundline.



DETAIL T

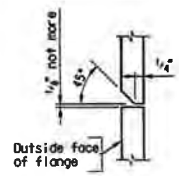


DETAIL W



ALTERNATE PILE SPLICE 2

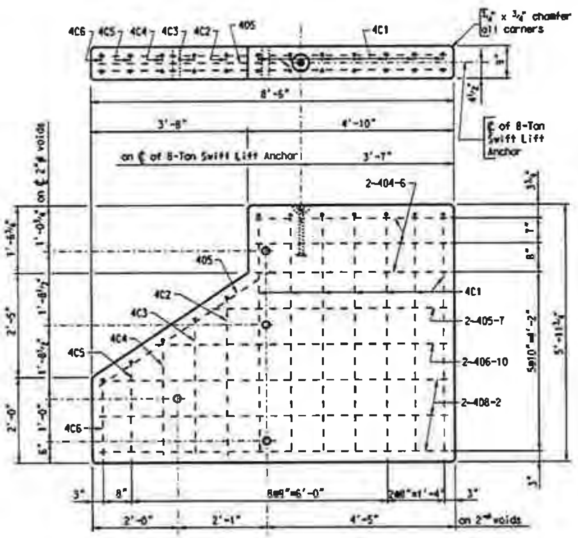
Prefabricated pile splices, if used, shall be located a minimum of 15 feet below finished groundline.



DETAIL V

H-PILE SPLICE DETAILS (Alternate 1 & 2)

REVISIONS			REVISIONS					
DATE	LTR	DESCRIPTION	DATE	LTR	DESCRIPTION	DES: RU	BNSF RAILWAY	28' & 33' PRESTRESSED CONCRETE SPANS - BNSF/UP COMMON BEAM SINGLE TRACK, 14' AND 15' DOUBLE TRACK CENTERS
						DRAWN: RU/VYT	BRIDGE ENGINEERING KANSAS CITY, KS	MISCELLANEOUS DETAILS
						CHECK: RGB	APPROVED: R G Berry	
						DATE: SEPT. 2009	ASST. DIRECTOR STRUCTURES DESIGN	PLAN NO: 0000-17902-088 SHEET: 13 of 24



PRECAST WING WALL PW103

Wt. = 4,800 lbs., Vol. = 1.13 cu. yds., Reinf. Steel = 143 lbs.

STEEL REQUIRED PER PRECAST MEMBER	
PW103	DESCRIPTION
	REINFORCING STEEL
1	4C1 (SEE DETAIL, SH. 17 OF 24)
1	4C2 (SEE DETAIL, SH. 17 OF 24)
1	4C3 (SEE DETAIL, SH. 17 OF 24)
1	4C4 (SEE DETAIL, SH. 17 OF 24)
1	4C5 (SEE DETAIL, SH. 17 OF 24)
1	4C6 (SEE DETAIL, SH. 17 OF 24)
6	404-6 (STRAIGHT)
1	405 (STRAIGHT)
2	405-7 (STRAIGHT)
2	406-10 (STRAIGHT)
6	408-2 (STRAIGHT)
	STRUCTURAL STEEL
1	8-TON SWIFT LIFT ANCHOR

NOTES:

GENERAL: ALL MATERIAL AND WORKMANSHIP SHALL BE AS PER THE CURRENT BNSF STANDARD SPECIFICATIONS.

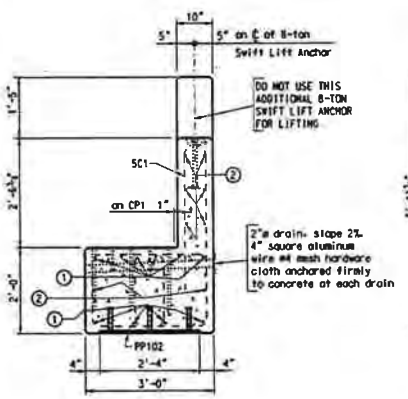
CONCRETE: THE ULTIMATE COMPRESSIVE STRENGTH OF CONCRETE SHALL BE NOT LESS THAN 4000 p.s.i. IN 28 DAYS. CONCRETE MEMBERS SHALL NOT BE REMOVED FROM THE CASTING BED BEFORE THE CONCRETE REACHES A STRENGTH OF 2500 p.s.i.

ALL EXPOSED EDGES OF CONCRETE MEMBERS SHALL BE CHAMFERED 3/4 INCH.

REINFORCEMENT: MILD STEEL REINFORCEMENT SHALL MEET THE REQUIREMENTS OF THE CURRENT A.S.T.M. DESIGNATION: A615 OR A706, GRADE 60.

FABRICATION OF REINFORCEMENT SHALL BE IN ACCORDANCE WITH CHAPTER 7 OF THE CURRENT C.R.S.I. MANUAL OF STANDARD PRACTICE.

MINIMUM CONCRETE COVER ON REINFORCEMENT SHALL BE TWO (2) INCHES.

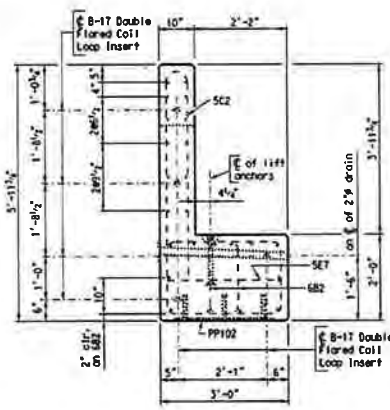


SECTION A-A

For further designation of horizontal bars see elevations of precast members

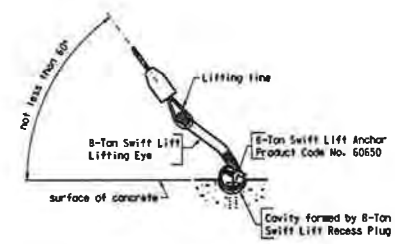
① 718-2 for CPC1
715-11 for CPC2L
716-5 for CPC3L

② 518-2 for CPC1
515-11 for CPC2L
516-5 for CPC3L



VIEW B-B

For further designation of horizontal bars, see elevations of precast members



LIFTING DETAIL

8-Ton Swift Lift Recess Plugs, Anchors and Lifting Eyes are available from Dayton/Richmond 721 Richard St., Miamisburg, Ohio 45342, Telephone (937) 866-0711. The materials for this lifting system are not included in the Bill of Material but are to be ordered as required.

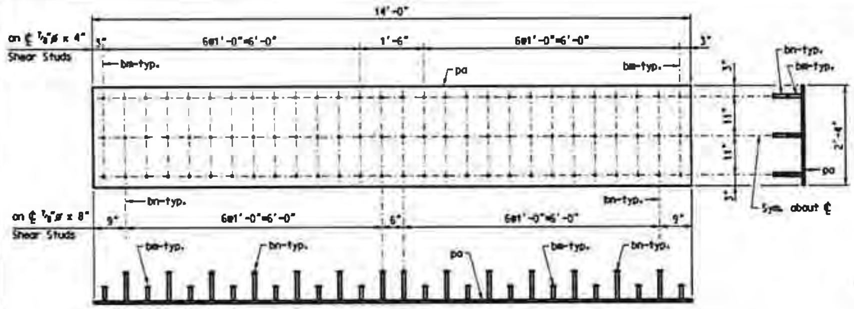
REVISIONS			
DATE	LTR	DESCRIPTION	
			DES: RU
			DRAWN: RU/VVT
			CHECK: RGB
			DATE: SEPT. 2009

BNSF RAILWAY
BRIDGE ENGINEERING, KANSAS CITY, KS
APPROVED: R G Berry
ASST. DIRECTOR STRUCTURES DESIGN

28' & 33' PRESTRESSED CONCRETE SPANS - BNSF/UP COMMON BEAM SINGLE TRACK, 14' AND 15' DOUBLE TRACK CENTERS

PRECAST CONCRETE MEMBERS

PLAN NO: 0000-17902-091



PILE PLATE PP102

1-Plate 3/4" x 28" x 14'-0"-pa
42-7/8"ø x 4" Shear Studs-bm
42-7/8"ø x 8" Shear Studs-bn
Weight = 1,087 lbs.

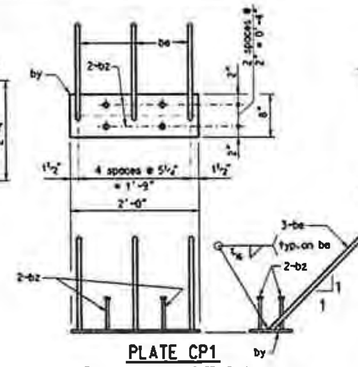


PLATE CP1

This is a combined BNSF-UP element
1-Bar 8" x 1/2" x 2'-0"-by
3-Bars #6 x 2'-0" (A706)-be
4-1/2"ø x 6" Shear Studs-bz
Weight = 40 lbs.

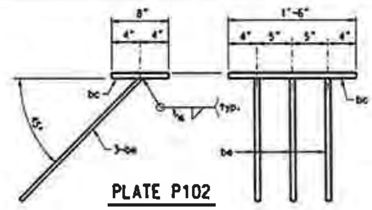


PLATE P102

1-Bar 8" x 3/4" x 1'-6"-bc
3-Bars #6 x 2'-0" (A706)-be
Weight = 39.6 lbs.

GENERAL NOTES:

MATERIAL: STRUCTURAL STEEL PLATES AND BARS SHALL MEET THE REQUIREMENTS OF THE CURRENT A.S.T.M. DESIGNATION: A36.

SHEAR CONNECTOR STUDS SHALL MEET THE REQUIREMENTS OF SECTION 7 OF THE CURRENT A.W.S. STRUCTURAL WELDING CODE D1.1 FOR GRADE 1020 SOLID FLUX FILLED HEADED STUDS.

D-RINGS SHALL BE 3" I.D., MADE OF STEEL FOR HEAVY-DUTY USE, PROVIDED WITH WELD-ON BRACKET, AND HAVE A MIN. SAFE WORKING LOAD OF 1,000 LBS.

FABRICATION NOTES:

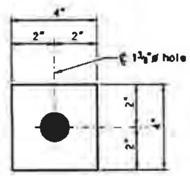
SHOP NOTES: FABRICATION AND ARC WELDING OF STRUCTURAL STEEL SHALL BE IN ACCORDANCE WITH CHAPTER 15, PART 3 OF THE CURRENT A.R.E.M.A. MANUAL FOR RAILWAY ENGINEERING.
OPEN HOLES: AS NOTED. SHOP PAINT: NONE.

DEFORMED BILLET REINFORCING BARS THAT ARE WELDED TO THE STEEL PLATES SHALL CONFORM TO A.S.T.M. A706, GR. 60.

SHEAR CONNECTOR STUDS SHALL BE AUTOMATICALLY END WELDED WITH COMPLETE FUSION IN ACCORDANCE WITH SECTION 7 OF THE CURRENT A.W.S. STRUCTURAL WELDING CODE D1.1.

GALVANIZING: CDP1, CDP2, CDP3, DP100, DP101, P100 AND W100 SHALL BE GALVANIZED AFTER FABRICATION IN ACCORDANCE WITH THE CURRENT A.S.T.M. DESIGNATION: A123.

AFTER GALVANIZING ALL ELEMENTS SHALL BE FREE OF FINS, ABRASIONS, ROUGH OR SHARP EDGES AND OTHER SURFACE DEFECTS.



WASHER W100

1-Bar 4" x 3/4" x 0'-4"
Weight = 3.4 lbs.
Galvanize after fabrication

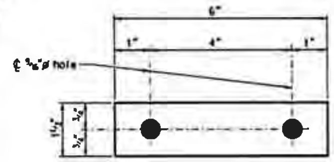
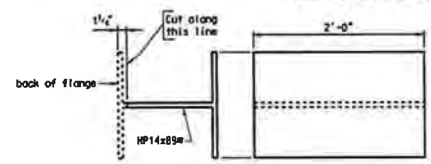


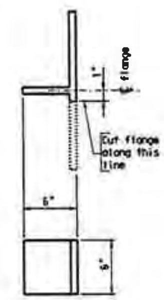
PLATE P100

1-Bar 1 1/2" x 1/4" x 0'-6"
Weight = 0.6 lbs.
Galvanize after fabrication



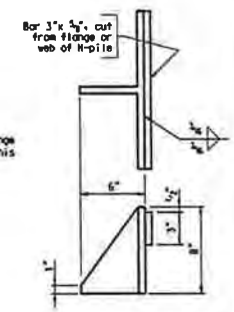
BRACKET B101

Field cut from HP14 x 89# Pile
Weight = 113 lbs.



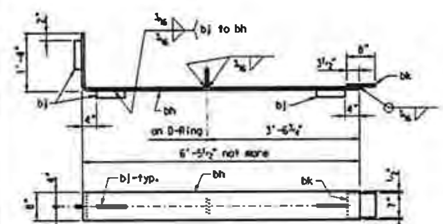
BRACKET CB2

Cut from HP14 x 89# Pile
Weight = 15 lbs.



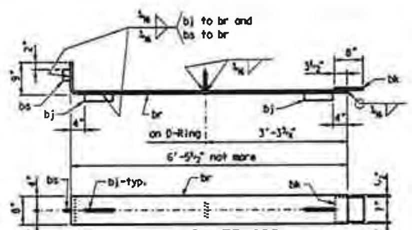
BRACKET B100

Cut from HP14 x 89# Pile
Weight = 30 lbs.



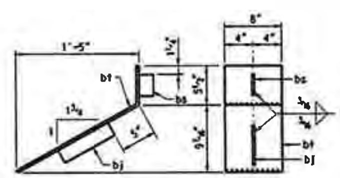
DECK PLATE DP100

1-Bar 8" x 3/8" x 7'-9 1/2" (Bent)-bh
3-Bars 2" x 3/8" x 0'-8"-bj
1-Bar 7" x 3/8" x 0'-8"-bk
1-D-Ring
Weight = 93 lbs.
Galvanize after fabrication



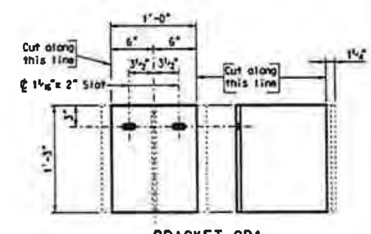
DECK PLATE CDP1

This is a combined BNSF-UP element
1-Bar 8" x 3/8" x 7'-2 1/2" (Bent)-br
1-Bar 7" x 3/8" x 0'-8"-bk
1-D-Ring
2-Bars 2" x 3/8" x 0'-8"-bj
1-Bar 2" x 3/8" x 0'-3"-bs
Weight = 86 lbs.
Galvanize after fabrication



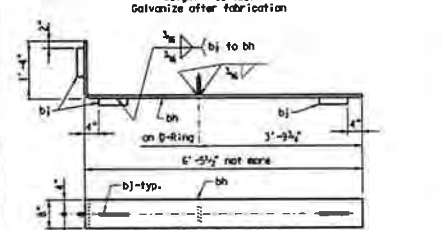
DECK PLATE CDP3

This is a combined BNSF-UP element
1-Bar 8" x 3/8" x 2'-0 1/2" (Bent)-bt
1-Bar 2" x 3/8" x 0'-8"-bj
1-Bar 2" x 3/8" x 0'-3"-bs
Weight = 23 lbs.
Galvanize after fabrication



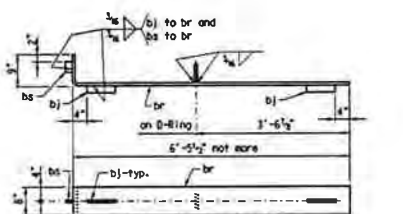
BRACKET CB1

Field cut from HP14 x 89# Pile
Weight = 65 lbs.



DECK PLATE DP101

1-Bar 8" x 3/8" x 7'-9 1/2" (Bent)-bh
3-Bars 2" x 3/8" x 0'-8"-bj
1-D-Ring
Weight = 87 lbs.
Galvanize after fabrication



DECK PLATE CDP2

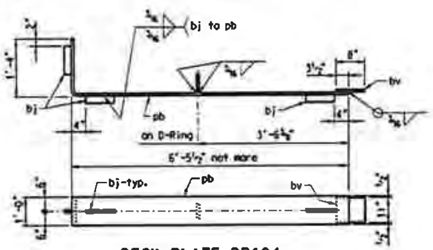
This is a combined BNSF-UP element
1-Bar 8" x 3/8" x 7'-2 1/2" (Bent)-br
2-Bars 2" x 3/8" x 0'-8"-bj
1-Bar 2" x 3/8" x 0'-3"-bs
1-D-Ring
Weight = 80 lbs.
Galvanize after fabrication

REVISIONS			
DATE	LTR	DESCRIPTION	DES: RU
			DRAWN: RU/VVT
			CHECK: RGB
			DATE: SEPT. 2009

BNSF RAILWAY
BRIDGE ENGINEERING KANSAS CITY, KS
APPROVED: R G B[illegible]
ASST. DIRECTOR STRUCTURES DESIGN

28' & 33' PRESTRESSED CONCRETE SPANS - BNSF/UP COMMON BEAM SINGLE TRACK, 14' AND 15' DOUBLE TRACK CENTERS
STEEL DETAILS

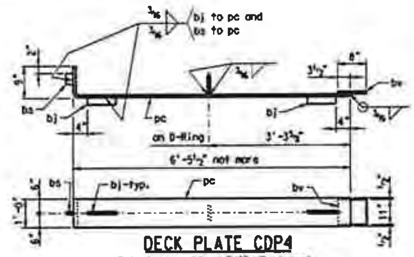
PLAN NO: 0000-17902-094 | SHEET: 19 of 24



DECK PLATE DP104

1-Plate $\frac{3}{8}$" x 12" x 7'-9½" (Bent)-pb
3-Bars 2" x $\frac{3}{8}$" x 0'-8"-bj
1-Bar 8" x $\frac{3}{8}$" x 0'-11"-bv
1-D-Ring

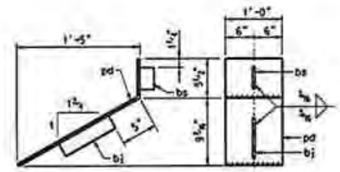
Weight = 136 lbs.
Galvanize after fabrication



DECK PLATE CDP4

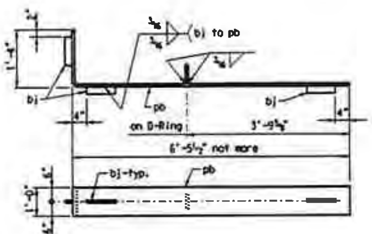
This is a combined BNSF-UP element
1-Plate $\frac{3}{8}$" x 12" x 7'-2½" (Bent)-pc
2-Bars 2" x $\frac{3}{8}$" x 0'-8"-bj
1-Bar 2" x $\frac{3}{8}$" x 0'-3"-bs
1-Bar 8" x $\frac{3}{8}$" x 0'-11"-bv
1-D-Ring

Weight = 127 lbs.
Galvanize after fabrication



DECK PLATE CDP6

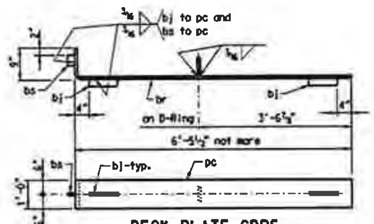
This is a combined BNSF-UP element
1-Plate $\frac{3}{8}$" x 12" x 2'-0½"(Bent)-pd
1-Bar 2" x $\frac{3}{8}$" x 0'-8"-bj
1-Bar 2" x $\frac{3}{8}$" x 0'-3"-bs
Weight = 34 lbs.
Galvanize after fabrication



DECK PLATE DP105

1-Plate $\frac{3}{8}$" x 12" x 7'-9½" (Bent)-pb
3-Bars 2" x $\frac{3}{8}$" x 0'-8"-bj
1-D-Ring

Weight = 127 lbs.
Galvanize after fabrication



DECK PLATE CDP5

This is a combined BNSF-UP element
1-Plate $\frac{3}{8}$" x 12" x 7'-2½" (Bent)-pc
2-Bars 2" x $\frac{3}{8}$" x 0'-8"-bj
1-Bar 2" x $\frac{3}{8}$" x 0'-3"-bs
1-D-Ring
Weight = 117 lbs.
Galvanize after fabrication

GENERAL NOTES:

MATERIAL: STRUCTURAL STEEL PLATES AND BARS SHALL MEET THE REQUIREMENTS OF THE CURRENT A.S.T.M. DESIGNATION: A36.

D-RINGS SHALL BE 3" I.D., MADE OF STEEL FOR HEAVY-DUTY USE, PROVIDED WITH WELD-ON BRACKET, AND HAVE A MIN. SAFE WORKING LOAD OF 1,000 LBS.

FABRICATION NOTES:

SHOP NOTES: FABRICATION AND ARC WELDING OF STRUCTURAL STEEL SHALL BE IN ACCORDANCE WITH CHAPTER 15, PART 3 OF THE CURRENT A.R.E.M.A. MANUAL FOR RAILWAY ENGINEERING.
OPEN HOLES: AS NOTED. SHOP PAINT: NONE.

GALVANIZING: CDP4, CDP5, CDP6, DP104 AND DP105 SHALL BE GALVANIZED AFTER FABRICATION IN ACCORDANCE WITH THE CURRENT A.S.T.M. DESIGNATION: A123.

AFTER GALVANIZING ALL ELEMENTS SHALL BE FREE OF FINS, ABRASIONS, ROUGH OR SHARP EDGES AND OTHER SURFACE DEFECTS.

REVISIONS			
DATE	LTR	DESCRIPTION	DES: VVT
			DRAWN: VVT
			CHECK: RGB
			DATE: SEPT. 2009

BNSF RAILWAY
BRIDGE ENGINEERING KANSAS CITY, KS
APPROVED:
ASST. DIRECTOR STRUCTURES DESIGN

28' & 33' PRESTRESSED CONCRETE SPANS - BNSF/UP COMMON BEAM SINGLE TRACK, 14' AND 15' DOUBLE TRACK CENTERS
STEEL DETAILS

PLAN NO: 0000-17902-095 | SHEET: 20 of 24

GENERAL NOTES:

GENERAL: ALL MATERIAL AND WORKMANSHIP SHALL BE AS PER THE CURRENT BNSF STANDARD CONSTRUCTION SPECIFICATIONS.

PILING: PILES SHALL MEET THE MATERIAL REQUIREMENTS OF AND SHALL BE DRIVEN IN ACCORDANCE WITH, THE BNSF STANDARD CONSTRUCTION SPECIFICATIONS. STEEL BEARING PILES SHALL BE DRIVEN TO REFUSAL, IF POSSIBLE, OR TO A MINIMUM ULTIMATE RESISTANCE OF 250 TONS AS DETERMINED BY THE MODIFIED ENGINEERING NEWS-RECORD FORMULA AS PER THE BNSF ENGINEERING INSTRUCTIONS, 17.2.6. IF PENETRATION OF 25 FEET BELOW NATURAL OR FINISHED GROUND LINE, WHICHEVER IS LOWER, CANNOT BE ACHIEVED, CONTACT SYSTEM STRUCTURES OFFICE.

AFTER PILES ARE DRIVEN, THEY SHALL BE PULLED, IF NECESSARY, AND HELD IN THE PROPER LOCATION AND CUT OFF AT THE PROPER ELEVATION. THEY SHALL CONTINUE BEING HELD UNTIL THE PRECAST CAPS HAVE BEEN SET AND WELDED TO STEEL BEARING PILES.

PLACING PRECAST CAPS ON STEEL H-PILES: PRECAST CAPS SHALL BE PLACED IN THE PROPER LOCATION AND THE PILES SHALL BE WELDED TO THE PILE PLATES. CHANNEL BRACING SHALL THEN BE WELDED TO THE PILES. SEE SHEETS 4 THRU 12 OF 24 FOR WELDING OF PILES TO PILE PLATES AND CHANNEL BRACING TO PILES. ARC WELDING SHALL BE AS PER THE CURRENT A.W.S. STRUCTURAL WELDING CODE D1.1.

ERECTION OF BEAMS: BEAMS SHALL BE SET IN THE PROPER LOCATION USING CARE NOT TO DAMAGE CONCRETE MEMBERS. AFTER BEAMS ARE SET, BURN OFF LIFTING LOOPS TWO (2) INCHES ABOVE CONCRETE SURFACE. REMAINING PORTION OF LIFTING LOOPS ARE TO BE COATED WITH PAINT. PATCH RECESSES, IF NECESSARY, AROUND LIFTING LOOPS WITH EPOXY MORTAR AS USED FOR SETTING BEAMS.

MORTAR FOR SETTING BEAMS: BEAMS SHALL HAVE FULL AND EVEN BEARING UPON THE BRIDGE SEAT AREAS. IF NEEDED, MORTAR CONSISTING OF EQUAL PARTS BY VOLUME OF CLASS B EPOXY AND DRY SILICA SAND, MIXED IN ACCORDANCE WITH MANUFACTURER'S DIRECTIONS, SHALL BE SPREAD ON TOP OF BEARING PADS TO OBTAIN UNIFORM BEARING. SCRAPE EXCESS MORTAR FROM AROUND BEARING PADS AFTER BEAMS ARE SET.

DECK PLATES: THE DECK PLATES SHALL BE ADJUSTED AS NECESSARY TO INSURE THE PLATES FIT TIGHT AGAINST THE BEAMS AND CURBS.

HANDRAIL: HANDRAIL PANELS ON WALKWAYS SHALL BE ERECTED PLUMB AND IN LINE.

PAINTING: THE EXPOSED PORTION OF PILE PLATES, THE EXPOSED PORTION OF PILING BETWEEN BOTTOM OF CAP AND ONE (1) FOOT BELOW GROUND LINE AND THE CHANNEL BRACING SHALL BE PAINTED WITH ONE (1) FIELD COAT OF CHEMICAL-MASTIC CM-15, METALLIC ALUMINUM COLOR, APPLIED TO A DRY FILM THICKNESS OF 8 MILS, CORRESPONDING TO A WET FILM THICKNESS OF 10 MILS.

ALL AREAS TO BE PAINTED SHALL HAVE A "COMMERCIAL BLAST CLEANING" IN ACCORDANCE WITH THE STEEL STRUCTURES PAINTING COUNCIL SURFACE PREPARATION SPECIFICATION SSPC-SP6. PAINT APPLICATION SHALL BE IN ACCORDANCE WITH THE MANUFACTURER'S INSTRUCTIONS.

INFORMATION PERTAINING TO CHEMICAL-MASTIC CM-15 MAY BE OBTAINED FROM THE MANUFACTURER:

GULF COAST PAINT MANUFACTURING, INC.
30075 COUNTY ROAD 49
LOXLEY, AL 36551
PHONE (251) 964 - 7911
FAX (251) 964 - 7918

PATCHING: PATCHING OR REPAIR OF SPALLED OR CHIPPED PRECAST CONCRETE MEMBERS SHALL BE DONE USING COMPATCH V/O MORTAR, MIXED AND INSTALLED IN ACCORDANCE WITH MANUFACTURER'S WRITTEN INSTRUCTIONS.

COMPATCH V/O MORTAR CAN BE ORDERED FROM:

CONSPEC MARKETING & MANUFACTURING CO., INC.
4226 KANSAS AVENUE
KANSAS CITY, KS 66106
TOLL FREE (877) 416 - 3439

EPOXY: THE FOLLOWING EPOXY MATERIALS ARE APPROVED FOR USE.

CLASS B EPOXY: AS23-18 A&B GEL TYPE EPOXY (1)

SPEC-BOND 200 EPOXY (2)

(1) AS23-18 EPOXY IS AVAILABLE FROM:

DELTA PLASTICS CO.
10513 ROAD 236
TERRA BELLA, CA 93270
PHONE (559) 535 - 1332
FAX (559) 535 - 3723

OR

PERMALITE
1537 MONROVIA AVE.
NEWPORT BEACH, CA 92663
PHONE (949) 548 - 1137
FAX (949) 548 - 1130

(2) SPEC-BOND EPOXY IS AVAILABLE FROM:

CONSPEC MARKETING & MANUFACTURING CO., INC.
4226 KANSAS AVENUE
KANSAS CITY, KS 66106
TOLL FREE (877) 416 - 3439

'H' PILE INTERIOR BENTS *						
	SINGLE BENTS			DOUBLE BENT PIERS		
SPANS \ "X"	UP TO 12'-0	12'-1 22'-0	22'-1 30'-0	UP TO 12'-0	12'-1 22'-0	22'-1 30'-0
2-28' S.T.	H1	H2	H3	H7	H8	H9
1-28' & 1-33' S.T.	H1	H2	H6	H7	H8	H9
2-33' S.T.	H4	H5	H6	H7	H8	H9
BENT TYPES FOR 14'-0 TRACK CENTERS						
2-28' D.T.	H10	H11	H12	H16	H17	H18
1-28' & 1-33' D.T.	H10	H11	H15	H16	H17	H18
2-33' D.T.	H13	H14	H15	H16	H17	H18
BENT TYPES FOR 15'-0 TRACK CENTERS						
2-28' D.T.	H19	H20	H21	H25	H26	H27
1-28' & 1-33' D.T.	H19	H20	H24	H25	H26	H27
2-33' D.T.	H22	H23	H24	H25	H26	H27

* NOT FOR CONSTRUCTION. FOR PLANNING AND ESTIMATING PURPOSES ONLY. FOR BENTS TO BE CONSTRUCTED SEE 'BILL OF MATERIAL SHEET'.

S.T. = SINGLE TRACK
D.T. = DOUBLE TRACK

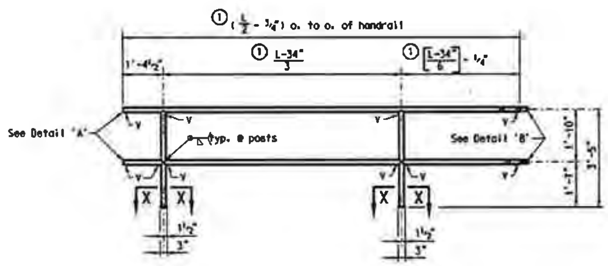
REVISIONS			DES: RU
DATE	LTR	DESCRIPTION	DRAWN: RU/VVT
			CHECK: RGB
			DATE: SEPT. 2009

BNSF RAILWAY
BRIDGE ENGINEERING - KANSAS CITY, KS
APPROVED: R G Berry
ASST. DIRECTOR STRUCTURES DESIGN

28' & 33' PRESTRESSED CONCRETE SPANS - BNSF/UP COMMON BEAM SINGLE TRACK, 14' AND 15' DOUBLE TRACK CENTERS
GENERAL NOTES

PLAN NO: 0000-17902-099

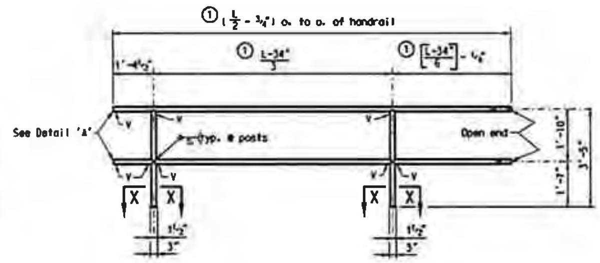
① 'L' is the length of the 30" x 7'-0 Prestressed Concrete Double Cell Box Beams as per Plan Numbers 0000-17003-001 and 0000-17003-002.



INTERIOR HANDRAIL PANEL (MALE)

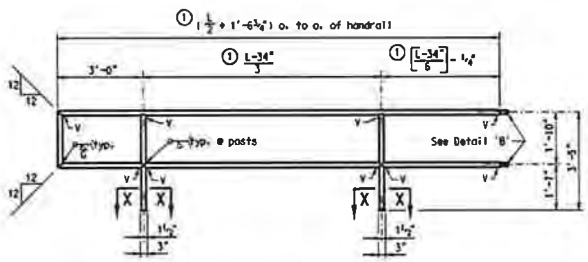
Handrail panels are to be fabricated using 1 1/2"ø std. black pipe. Galvanize after fabrication.

v = 3/8"ø drilled vent hole 1" from joint, except as dimensioned in Detail 'B'.



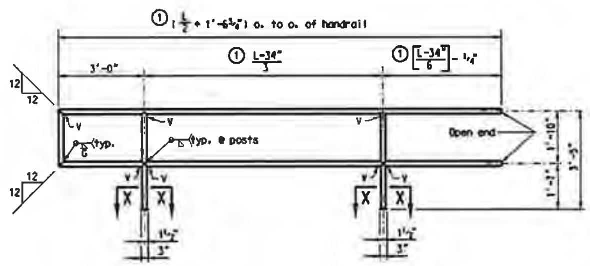
INTERIOR HANDRAIL PANEL (FEMALE)

Handrail panels are to be fabricated using 1 1/2"ø std. black pipe. Galvanize after fabrication.



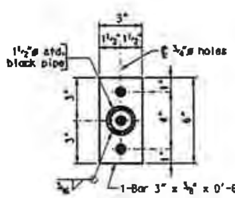
END HANDRAIL PANEL (MALE)

Handrail panels are to be fabricated using 1 1/2"ø std. black pipe. Galvanize after fabrication.

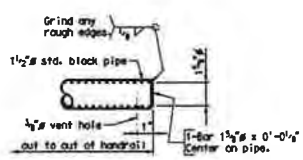


END HANDRAIL PANEL (FEMALE)

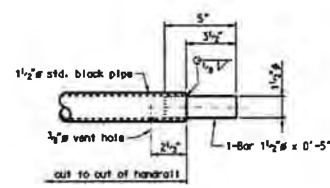
Handrail panels are to be fabricated using 1 1/2"ø std. black pipe. Galvanize after fabrication.



SECTION X-X



DETAIL 'A'



DETAIL 'B'

NOTES:

MATERIAL: STRUCTURAL STEEL BARS SHALL MEET THE REQUIREMENTS OF THE CURRENT A.S.T.M. DESIGNATION: A36.

STANDARD BLACK PIPE SHALL MEET THE REQUIREMENTS OF THE CURRENT A.S.T.M. DESIGNATION: A53. UNCOATED PIPE SHALL BE USED.

SHOP NOTES: FABRICATION AND ARC WELDING OF STRUCTURAL STEEL AND HANDRAIL PANELS SHALL BE IN ACCORDANCE WITH CHAPTER 15, PART 3 OF THE CURRENT A.R.E.M.A. MANUAL FOR RAILWAY ENGINEERING. MIG WELDING SHALL BE USED ON HANDRAIL PANELS.
OPEN HOLES: AS NOTED. SHOP PAINT: NONE.

GALVANIZING: HANDRAIL PANELS SHALL BE GALVANIZED AFTER FABRICATION IN ACCORDANCE WITH THE CURRENT A.S.T.M. DESIGNATION: A123.

AFTER GALVANIZING ALL ELEMENTS SHALL BE FREE OF FINS, ABRASIONS, ROUGH OR SHARP EDGES AND OTHER SURFACE DEFECTS.

REVISIONS			
DATE	LTR	DESCRIPTION	
4/98	A	HANDRAIL FORMULA	
1/06	B	TITLE BLOCK	

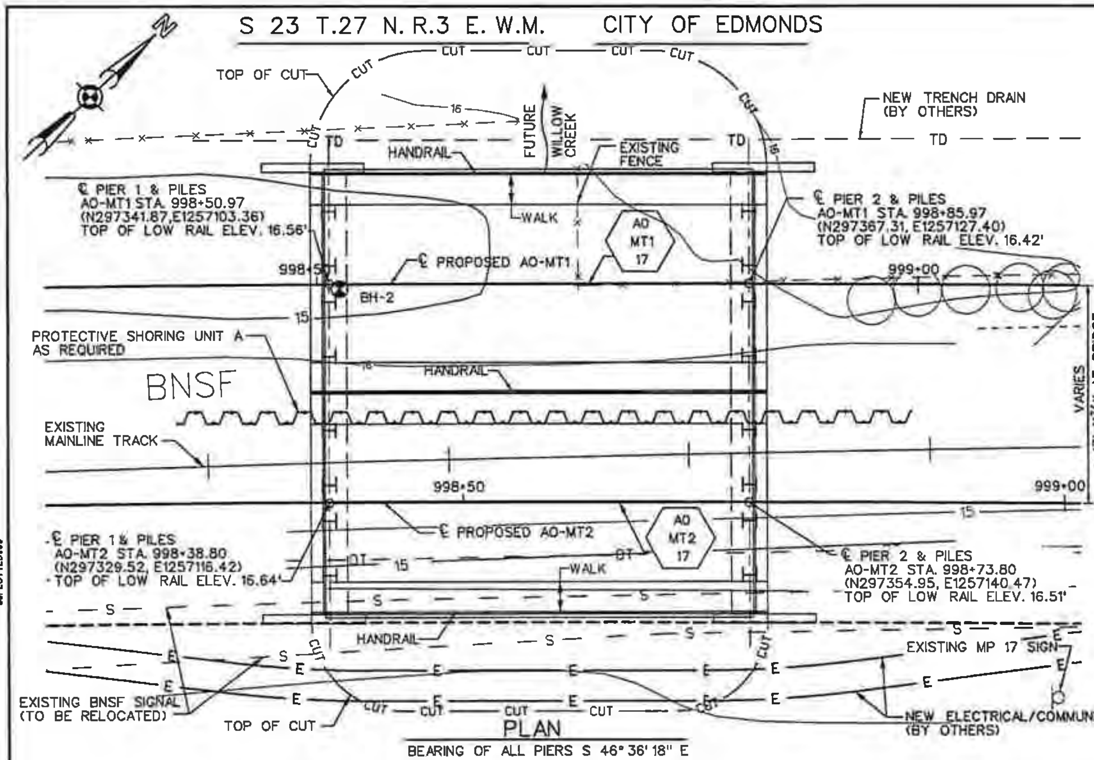
DES: RU
DRAWN: RU
CHECK: KHJ
DATE: MAR. 1998

BNSF RAILWAY
BRIDGE ENGINEERING, KANSAS CITY, KS
APPROVED:
ASST. DIRECTOR STRUCTURES DESIGN

30" x 7'-0 PRESTRESSED CONCRETE DOUBLE BOX BEAMS AND BNSF/UP COMMON BEAM
HANDRAIL PANEL DETAILS FOR MULTIPLE LENGTH BEAMS

PLAN NO: 0000-17000-001B
SHEET: 1 of 1

APPENDIX C
CONSTRUCTION PLANS



PLAN

BEARING OF ALL PIERS S 46° 36' 18" E

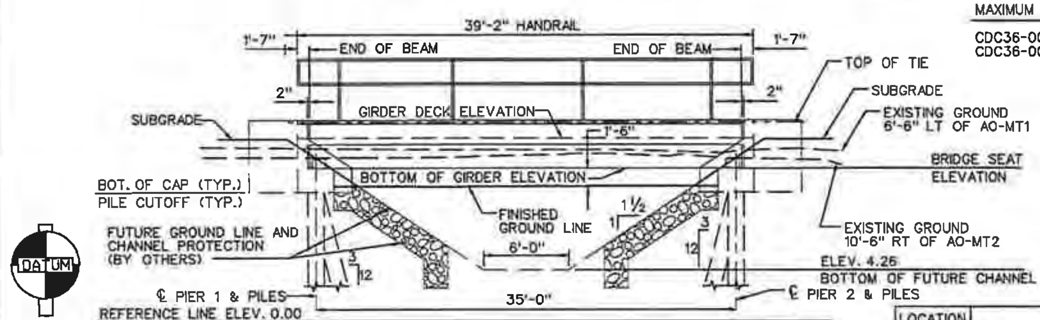
GENERAL NOTES:

1. ALL MATERIAL AND WORKMANSHIP SHALL BE IN ACCORDANCE WITH THE REQUIREMENTS OF THE CURRENT PLANS AND CONTRACT DOCUMENTS.
2. A GEOTECHNICAL INVESTIGATION HAS BEEN CONDUCTED, A REPORT PREPARED AND IS ATTACHED AS AN APPENDIX TO THE SPECIFICATIONS.
3. THE BRIDGE SHALL BE CONSTRUCTED USING 30" X 7'-0" PRESTRESSED CONCRETE DOUBLE BOX BEAMS IN ACCORDANCE WITH THE FOLLOWING BNSF STANDARD PLANS, AND THE GEOMETRY AND MODIFICATIONS SHOWN ON THESE PLANS:

STANDARD PLAN NO.	SHEET NO.	STANDARD PLAN NO.	SHEET NO.
500000 BG1	1 OF 3	0000-17902-088	13 OF 24
500000 BG2	2 OF 3	0000-17902-091	16 OF 24
500000 BG3	3 OF 3	0000-17902-094	19 OF 24
0000-17902-076	1 OF 24	0000-17902-095	20 OF 24
0000-17902-077	2 OF 24	0000-17902-099	24 OF 24
0000-17902-078	3 OF 24	0000-17000-01B	1 OF 1

OTHER STANDARD PLANS AS APPLICABLE AND APPROVED BY THE ENGINEER.

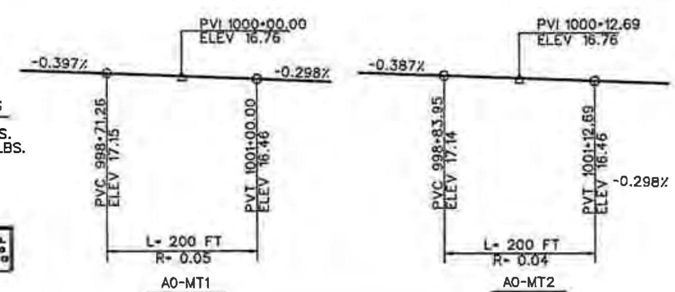
4. THE BEAM ARRANGEMENT SHALL BE IN ACCORDANCE WITH THE TYPICAL SECTION ON DRAWING BR3.
5. PILES SHALL BE H-PILES WITH MATERIALS AS SPECIFIED IN THE BNSF STANDARD SPECIFICATIONS AND STANDARD PLANS, AND DIMENSIONS AS SHOWN IN THESE PLANS.
6. THE CONTRACTOR SHALL BE RESPONSIBLE FOR THE STABILITY OF THE STRUCTURE DURING CONSTRUCTION. TEMPORARY SUPPORTS AND FALSEWORK SHALL BE GRADUALLY RELEASED TO PREVENT IMPACT OR UNDUE STRESSES IN THE STRUCTURE.
7. THE LOCATIONS OF ALL EXISTING UTILITIES WITHIN THE VICINITY OF THE STRUCTURES SHALL BE VERIFIED BY THE CONTRACTOR PRIOR TO EXCAVATING OR DRIVING PILES.
8. UNLESS OTHERWISE NOTED IN THE PLANS, ALL DIMENSIONS ARE HORIZONTAL AND VERTICAL BASED ON A TEMPERATURE OF 64 DEGREES F (MEAN TEMPERATURE DURING CONSTRUCTION).
9. FOR TRACK ALIGNMENT GEOMETRY SEE BNSF EDMONDS DRAWING NO'S P207-P208 AND P216-P217.
10. SHORING SHALL BE DESIGNED AND CONSTRUCTED IN ACCORDANCE WITH THE LATEST EDITION OF THE BNSF "GUIDELINES FOR TEMPORARY SHORING".
11. FOR SURVEY CONTROL AND BENCHMARK ELEVATIONS AND LOCATIONS, SEE BNSF EDMONDS DRAWING G206.



ELEVATION - SINGLE SPAN BRIDGE

MAXIMUM LIFTING WEIGHTS

CDC36-00W - 64,000 LBS.
CDC36-00SCW - 61,800 LBS.



PROFILE GRADE

PROFILE SHOWN IS AT TOP OF LOW RAIL

BRIDGE ELEVATION TABLE

* ELEVATION IS AT TOP OF TIE AT LOW RAIL

LOCATION	TOP OF TIE*	GIRDER DECK	BOT. OF GIRDER	BRIDGE SEAT	BOT. OF CAP/PILE CUTOFF
PIER 1	16.56 (AO-MT1)*, 16.64 (AO-MT2)*	15.17	12.67	12.60	10.60
PIER 2	16.42 (AO-MT1)*, 16.51 (AO-MT2)*	15.17	12.67	12.60	10.60

5/20/2010

CONSULTANT		DATE
DESIGNED BY	V BACURIN	04-02-10
ENTERED BY	V BACURIN	04-02-10
CHECKED BY	K LINTS	04-02-10
PROJ. MGR.	K LINTS	04-02-10

ISSUE				BNSF APPROVALS		
NO.	DATE	BY	DESCRIPTION	DEPARTMENT	SIGNATURE	DATE

AECOM
10900 NE 8th Street, Suite 750
Bellevue, Washington 98004
Phone: (425) 454-5600 Fax: (425) 454-0220

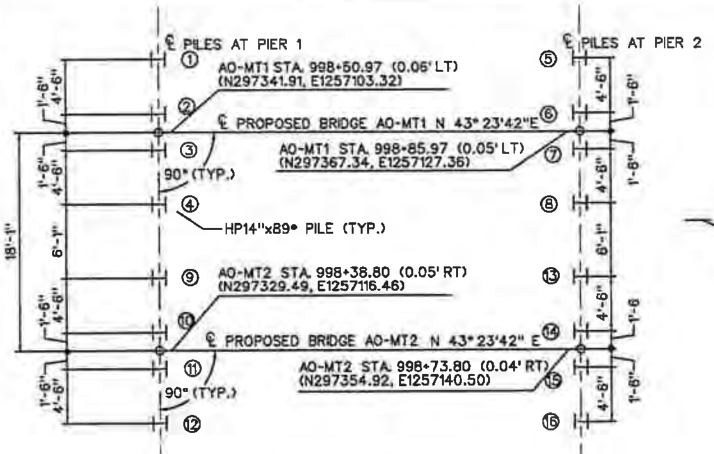
BNSF RAILWAY

FINAL DESIGN
FOR SOUND TRANSIT COMMUTER RAIL
SEATTLE TO EVERETT, WASHINGTON
GRADING AND STRUCTURES

BRIDGE LAYOUT
LS 50, BR.16.90

DWG NO BR1

SHEET 1 OF 4 SHEETS



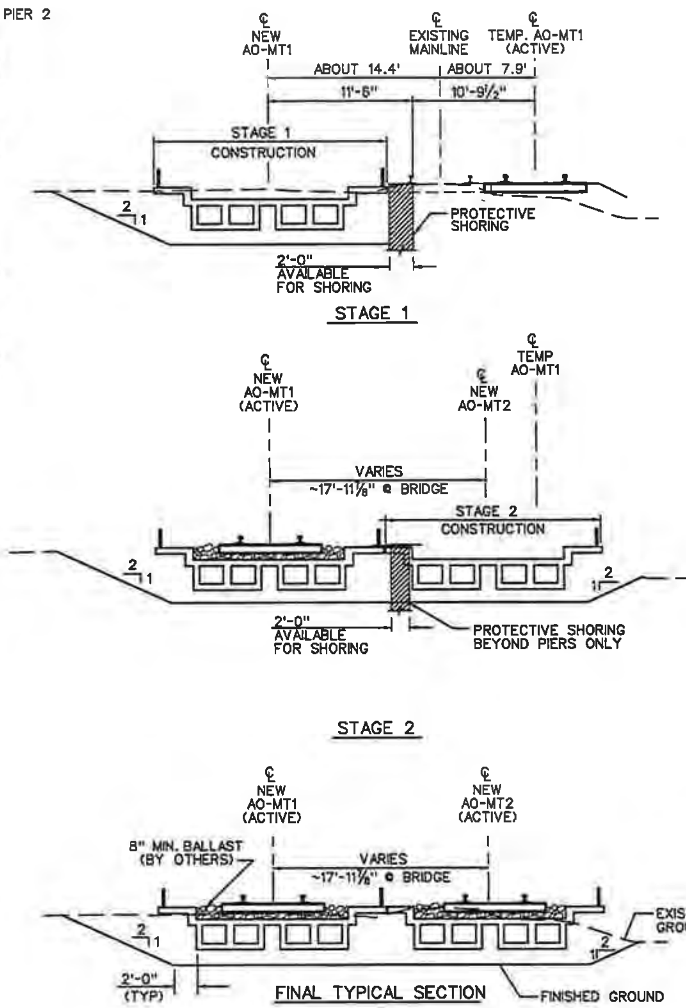
PILE LAYOUT

NOTES:

1. PILES SHALL BE DRIVEN BATTERED, AS SHOWN ON DRAWING BR4.
2. PILE LOCATIONS SHOWN ARE AT THE BOTTOM OF THE CAP BEAM.
3. ESTIMATED PILE EMBEDMENT IS 36 FEET BELOW THE BOTTOM OF THE CAP BEAM.

PILE COORDINATE TABLE

PILE NO.⊛	NORTHING	EASTING
1	297346.03	1257098.96
2	297342.94	1257102.23
3	297340.88	1257104.41
4	297337.79	1257107.68
5	297371.46	1257123.00
6	297368.37	1257126.27
7	297366.31	1257128.45
8	297363.22	1257131.72
9	297333.61	1257112.10
10	297330.52	1257115.37
11	297328.46	1257117.55
12	297325.36	1257120.82
13	297359.04	1257136.14
14	297355.95	1257139.41
15	297353.89	1257141.59
16	297350.80	1257144.86



BRIDGE STAGING

LOOKING NORTH (RR EAST)

STAGE 1 CONSTRUCTION:

1. CONSTRUCT AO-MT1 SUBGRADE IN TEMPORARY LOCATION (BY OTHERS).
2. SHIFT EXIST MAINLINE TRACK AND TRAFFIC TO TEMPORARY AO-MT1 (BY BNSF).
3. CONSTRUCT PROTECTIVE SHORING.
4. EXCAVATE AND CONSTRUCT BRIDGE AT PROPOSED AO-MT1.

STAGE 2 CONSTRUCTION:

1. CONSTRUCT AO-MT1 SUBGRADE (BY OTHERS).
2. CONSTRUCT AO-MT1 TRACK AND SHIFT TRAFFIC FROM TEMP. AO-MT1 TO AO-MT1 (BY BNSF).
3. REMOVE PROTECTIVE SHORING BETWEEN PIERS 1 & 2. PROTECTIVE SHORING BEYOND PIERS TO REMAIN.
4. REMOVE AO-MT2 TRACK AT BRIDGE (BY BNSF).
5. EXCAVATE AND CONSTRUCT BRIDGE AT PROPOSED AO-MT2.
6. CONSTRUCT AO-MT2 SUBGRADE (BY OTHERS).
7. REMOVE REMAINING PROTECTIVE SHORING.

FINAL:

1. CONSTRUCT PROPOSED AO-MT2 AND INSTALL TRACK ACROSS BRIDGE (BY BNSF).
2. OPEN AO-MT2 TO TRAFFIC (BY BNSF).

5/20/2010

CONSULTANT		DATE
DESIGNED BY	V BACURIN	04-02-10
ENTERED BY	V BACURIN	04-02-10
CHECKED BY	K LINTS	04-02-10
PROJ. MGR.	K LINTS	04-02-10

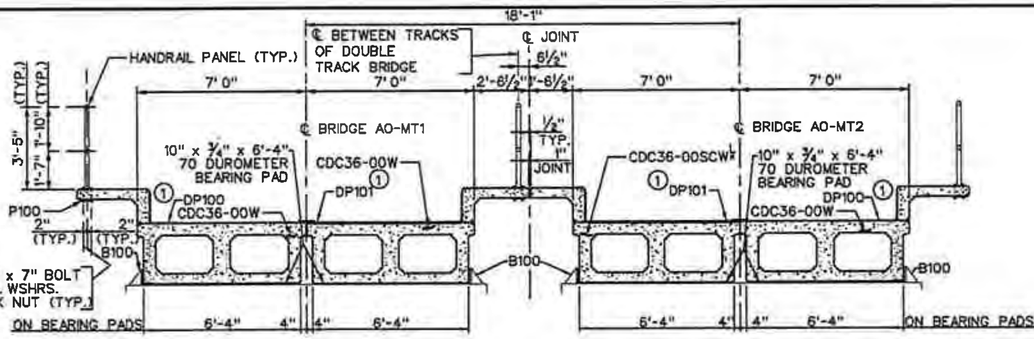
ISSUE NO.	DATE	BY	DESCRIPTION	BNSF APPROVALS DEPARTMENT	SIGNATURE	DATE

AECOM
10900 NE 8th Street, Suite 750
Bellevue, Washington 98004
Phone: (425) 454-5600 Fax: (425) 454-0220

BNSF RAILWAY

FINAL DESIGN
FOR SOUND TRANSIT COMMUTER RAIL
SEATTLE TO EVERETT, WASHINGTON
GRADING AND STRUCTURES
PILE LAYOUT AND CONSTRUCTION STAGING
LS 50, BR.16.90

DWG NO BR2
SHEET 2 OF 4 SHEETS

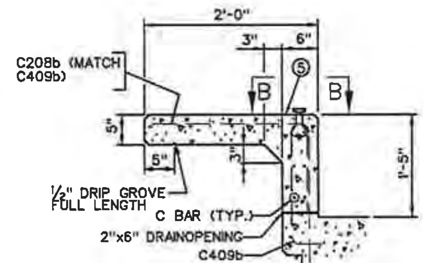


TYPICAL SECTION

LOOKING NORTH

① IF GAP, EITHER BETWEEN BEAMS OR BETWEEN BEAM AND PARAPET, IS ANTICIPATED TO BE GREATER THAN 3", USE DP104 & DP105 IN PLACE OF DP100 & DP101, RESPECTIVELY. ORDER DP104 & 105 ONLY AS NEEDED.

* SEE SPECIAL CURB SCW^L DETAIL ON THIS SHEET



SPECIAL CURB SCW^L DETAIL

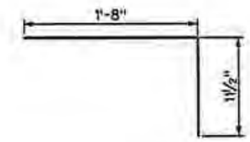
PRECAST CURB SCW^R IS OPPOSITE HAND OF SCW^L

⑤ 3"x6" I.D. PLATE IS TO BE EMBEDDED FLUSH IN TOP OF CURB AND CENTERED 6" FROM END OF CURB. PLATE SHALL CONTAIN THE FOLLOWING INFORMATION IN 1/2" LETTERING: ITEM NAME, LENGTH, WEIGHT, DATE MANUFACTURED AND NAME OF MANUFACTURER.

NOTE: SEE BNSF-UP STANDARD PLAN SHEET 500000 BG1 FOR VIEW B AND BNSF-UP STANDARD PLAN SHEETS 500000 BG1, BG2, & BG3 FOR ADDITIONAL DETAILS

BILL OF MATERIAL (SEE NOTE 1)

LINE	QTY.	UNIT	DESCRIPTION	MARK	SIZE	LENGTH	REMARKS
1	71,200	LBS.	STEEL BEARING PILE ASTM A36 (16 PIECES)		HP14X89	50'-0"	SEE NOTE 2
2							
3	4	EA.	PRECAST CONC. CAP - END BENT	CPC3W	3'-0"x5'-11¾"	18'-3"	PER DWG BR4 & PLAN 17902-090
4	4	EA.	PRECAST CONC. WINGWALL	PW103	9"x5'-11¾"	8'-6"	PER PLAN 17902-091
5	1	EA.	PRESTRESSED DOUBLE BOX BEAM WITH CUSTOM SPECIAL CURB	CDC36-00SCW^L	2'-6"x7'-0"	36'-0"	PER PLAN 500000 & DWG BR3
6	3	EA.	PRESTRESSED DOUBLE BOX BEAM WITH WALK	CDC36-00W	2'-6"x7'-0"	36'-0"	PER PLAN 500000
7							
8	16	EA.	SPIRAL BOLT		1/4" DIA.	1'-1"	PER PLAN 17902-078
9	16	EA.	WASHER, GALVANIZED	W100	4"x¾"	0'-4"	PER PLAN 17902-094
10	4	EA.	DECK PLATE, GALVANIZED	DP100	8"x⅜"	7'-9½"	PER PLAN 17902-094
11	4	EA.	DECK PLATE, GALVANIZED	DP101	8"x⅜"	7'-9½"	PER PLAN 17902-094
12							
13	8	EA.	RESTRAINER BRACKET	B100	PC OF HP14x89		PER PLAN 17902-094
14							
15	3	EA.	HANDRAIL PANEL, GALVANIZED	EHPM19-6.75	½" DIA. PIPE	19'-6¾"	PER PLAN 17000-001B
16	3	EA.	HANDRAIL PANEL, GALVANIZED	EPHF19-6.75	½" DIA. PIPE	19'-6¾"	PER PLAN 17000-001B
17	12	EA.	PLATE, GALVANIZED	P100	½"x¼"	0'-6"	PER PLAN 17902-094
18							
19	24	EA.	BOLT, HEX HEAD, GALVANIZED		½" DIA.	0'-7"	HANDRAIL POST
20	48	EA.	STANDARD WASHER FOR ½"Ø BOLT, GALVANIZED		½" DIA.		HANDRAIL POST
21	24	EA.	LOCK NUT FOR ½"Ø BOLT, GALVANIZED		½" DIA.		HANDRAIL POST
22							
23	8	EA.	URETHANE BEARING PAD - 70 DUROMETER		¾"x10"	6'-4"	PER PLAN 17902-077
24							
25	32	EA.	PREMOLDED JOINT FILLER, ASPH. IMPREG.		½"x28"	6'-4"	PER PLAN 17902-078



BAR C308b

SIZE IS #4

NOTE: FOR BAR DESIGNATION, SEE BNSF-UP STANDARD PLAN 500000 BG2.

NOTES:

1. BNSF TO FURNISH BRIDGE ITEMS SHOWN IN ABOVE BILL OF MATERIAL. IT IS THE RESPONSIBILITY OF THE CONTRACTOR TO PROVIDE PILE DRIVING, PILE SPLICES (IF NECESSARY), PAINT, AND ALL OTHER MATERIALS NOT LISTED IN THE ABOVE BILL OF MATERIALS TO PROPERLY ERECT THIS BRIDGE IN ACCORDANCE WITH THESE PLANS, SPECIAL PROVISIONS, AND BNSF STANDARD CONSTRUCTION SPECIFICATIONS.
2. ESTIMATED PILE EMBEDMENT PER GEOTECHNICAL REPORT RECOMMENDATION IS 36'-0" BELOW THE BOTTOM OF THE CAP BEAM. CONTRACTOR SHALL BE PREPARED TO SPLICE PILES OR USE LONGER PILES AS REQUIRED TO DEVELOP REQUIRED PILE CAPACITY.

5/20/2010

CONSULTANT		DATE
DESIGNED BY	V BACURIN	04-02-10
ENTERED BY	V BACURIN	04-02-10
CHECKED BY	K LINTS	04-02-10
PROJ. MGR.	K LINTS	04-02-10

ISSUE: NO. | DATE | BY | DESCRIPTION

BNSF APPROVALS: DEPARTMENT | SIGNATURE | DATE

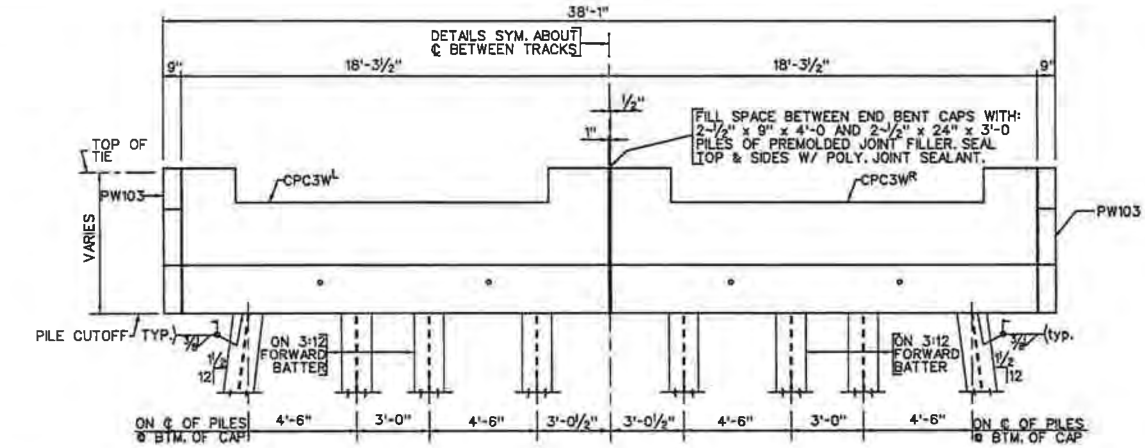
AECOM
10900 NE 8th Street, Suite 750
Bellevue, Washington 98004
Phone: (425) 454-5600 Fax: (425) 454-0220

BNSF RAILWAY

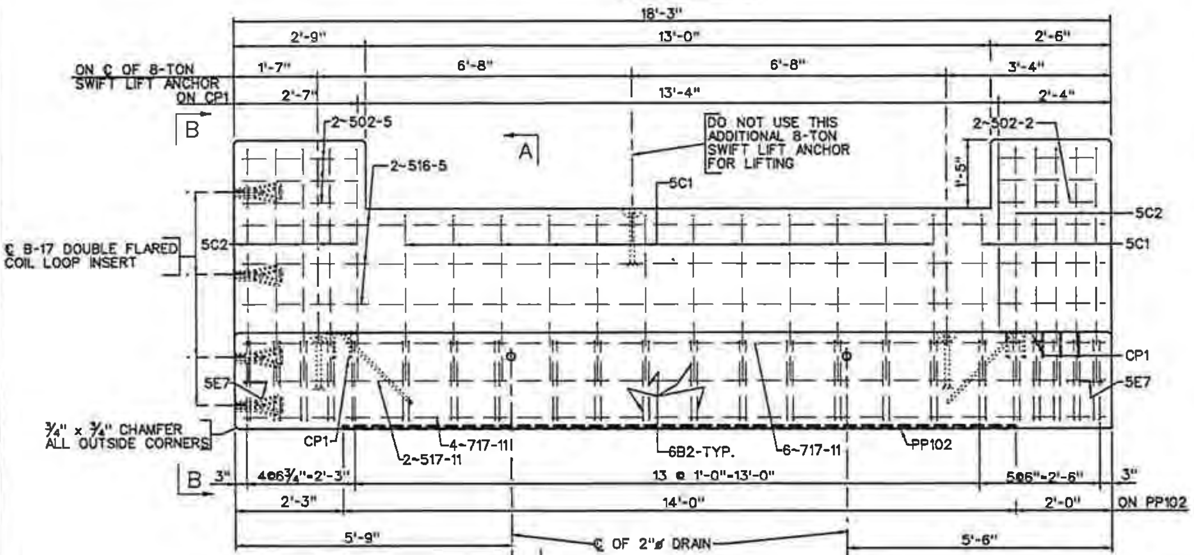
FINAL DESIGN
FOR SOUND TRANSIT COMMUTER RAIL
SEATTLE TO EVERETT, WASHINGTON
GRADING AND STRUCTURES
PRECAST MEMBER DETAILS
LS 50, BR.16.90

DWG NO BR3

SHEET 3 OF 4 SHEETS



END BENT



NOTE:
SEE BNSF STD. PLAN SHEET 17902-091 FOR SECTION A-A AND VIEW B-B

PRECAST CAP CPC3W^L

WT.= 23,800 LBS., VOL.= 5.88 CU. YDS., REINF. STEEL= 1,440 LBS.
PRECAST CAP CPC3^R IS OPPOSITE HAND OF CPC3^L

NOTES:

ALL PILES ARE HP14" x 89# STEEL BEARING PILES SEE BNSF STD. PLAN SHEET 17902-088 FOR "TYPICAL PILE SPLICE" DETAIL.

AFTER PRECAST CONCRETE MEMBERS ARE SET, FILL RECESSES AT LIFT ANCHORS WITH CEMENT GROUT TO TOP OF SURROUNDING CONCRETE.

GENERAL: ALL MATERIAL AND WORKMANSHIP SHALL BE AS PER THE CURRENT BNSF STANDARD SPECIFICATIONS.

COIL LOOP INSERTS ARE TO BE DOUBLE FLARED TYPE B17 1¼" DIA. x 12" AS MANUFACTURED BY DAYTON-SUPERIOR AND HAVE A SAFE WORKING LOAD OF 13,500 LBS. WITH A 4 TO 1 SAFETY FACTOR. THE INSERTS ARE TO BE COMPLETELY RECESSED WITH 1¼" DIA. x 13" SPIRAL BOLTS ATTACHED TO THE CAP FOR SHIPMENT.

CONCRETE: THE ULTIMATE COMPRESSIVE STRENGTH OF CONCRETE SHALL BE NOT LESS THAN 4000 P.S.I. IN 28 DAYS. CONCRETE MEMBERS SHALL NOT BE REMOVED FROM THE CASTING BED BEFORE THE CONCRETE REACHES A STRENGTH OF 2500 P.S.I.

ALL EXPOSED EDGES OF CONCRETE MEMBERS SHALL BE CHAMFERED ¾".

REINFORCEMENT: MILD STEEL REINFORCEMENT SHALL MEET THE REQUIREMENTS OF THE CURRENT A.S.T.M. DESIGNATION: A615 OR A706, GRADE 60.

FABRICATION OF REINFORCEMENT SHALL BE IN ACCORDANCE WITH CHAPTER 7 OF THE CURRENT C.R.S.I. MANUAL OF STANDARD PRACTICE.

STEEL REINFORCEMENT MAY BE MOVED SLIGHTLY SO AS TO MISS PP102 OR CP1.

MINIMUM CONCRETE COVER ON REINFORCEMENT SHALL BE TWO (2) INCHES.

STEEL REQUIRED PER PRECAST MEMBER

PRECAST MEMBER		DESCRIPTION
CPC3W^L	CPC3W^R	
		REINFORCING STEEL
46	46	6B2 (SEE DETAIL, BNSF STD. PLAN 0000-17902-092)
13	13	5C1 (SEE DETAIL, BNSF STD. PLAN 0000-17902-092)
10	10	5C2 (SEE DETAIL, BNSF STD. PLAN 0000-17902-092)
2	2	5E7 (SEE DETAIL, BNSF STD. PLAN 0000-17902-092)
6	6	502-2 (STRAIGHT, SIZE: #5, LENGTH: 2'-2")
6	6	502-5 (STRAIGHT, SIZE: #5, LENGTH: 2'-5")
8	8	517-11 (STRAIGHT, SIZE: #5, LENGTH: 17'-11")
10	10	717-11 (STRAIGHT, SIZE: #7, LENGTH: 17'-11")
		STRUCTURAL STEEL
4	4	1¼" x 12" DAYTON SUPERIOR B-17 DOUBLE FLARED COIL LOOP INSERT 1¼" x 12" LONG, 13,500 LBS. SWL (SAFE WORKING LOAD), PLAIN
3	3	8-TON SWIFT LIFT ANCHOR
2	2	PLATE CP1 (SEE DETAIL, BNSF STD. PLAN 0000-17902-094)
1	1	PILE PLATE PP102 (SEE DETAIL, BNSF STD. PLAN 0000-17902-094)

5/20/2010

CONSULTANT		DATE
DESIGNED BY	V BACURIN	04-02-10
ENTERED BY	V BACURIN	04-02-10
CHECKED BY	K LINTS	04-02-10
PROJ. MGR.	K LINTS	04-02-10

ISSUE				BNSF APPROVALS		
NO.	DATE	BY	DESCRIPTION	DEPARTMENT	SIGNATURE	DATE

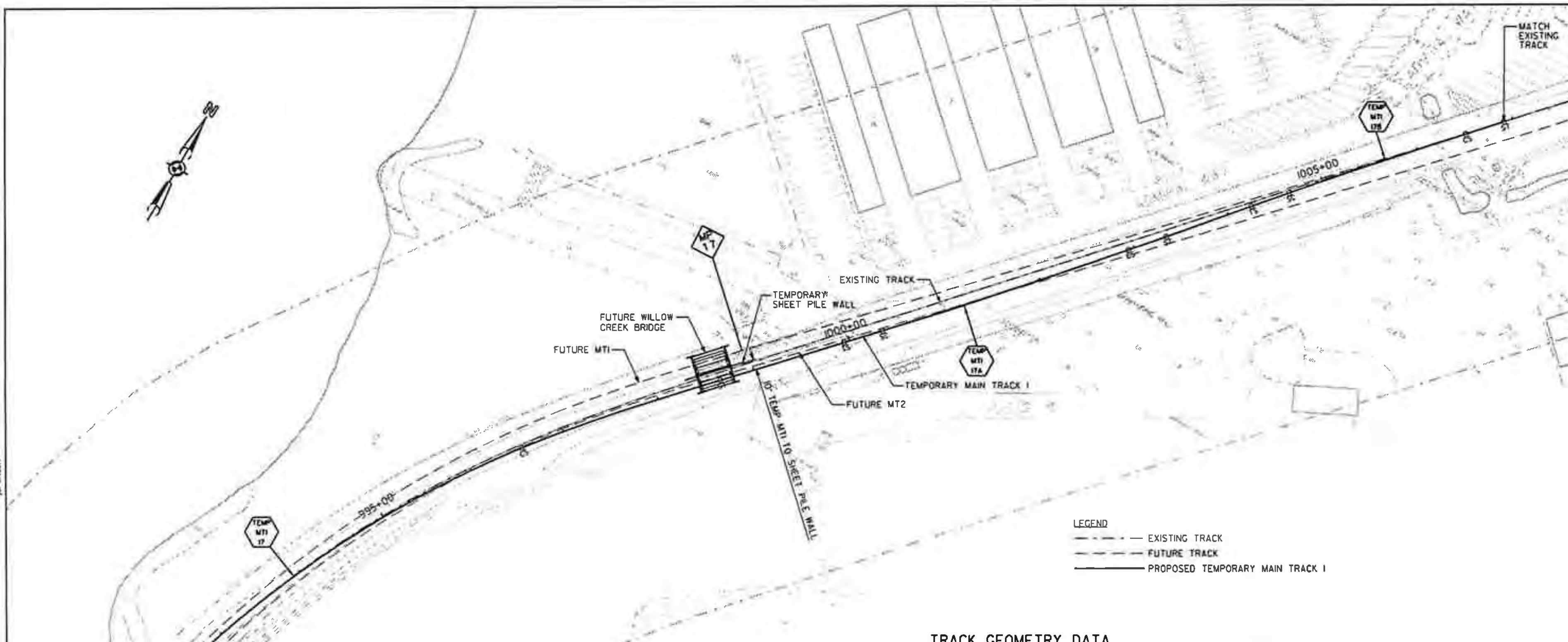
AECOM
10900 NE 8th Street, Suite 750
Bellevue, Washington 98004
Phone: (425) 454-5600 Fax: (425) 454-0220

BNSF RAILWAY

FINAL DESIGN
FOR SOUND TRANSIT COMMUTER RAIL
SEATTLE TO EVERETT, WASHINGTON
GRADING AND STRUCTURES
BRIDGE TYP. SECTION & END BENT DETAILS
LS 50, BR.16.90

DWG NO BR4
SHEET 4 OF 4 SHEETS

APPENDIX D
TEMPORARY MAIN TRACK PLAN



TRACK GEOMETRY DATA

ALIGNMENT NAME: TEMP MT1 DESCRIPTION: EDMONDS TEMPORARY MAINLINE TRACK 1 FOR CONSTRUCTION OF PHASE 1 OF WILLOW CREEK BRIDGE

ID NO.	DESC	STATION	NORTHING	EASTING	BEARING	DISTANCE	R	Dc	L	I	DELTA	THETA	Ls	X	Y	Ea Vp/Vf(MPH)
17	CS	991+81.88	296760.50	1256793.30								2°01'58"	40.00	39.99	0.71	4½" 45/40
	SC	992+21.88	296799.26	1256803.19			1109.23	5°10'00"	433.37	29°50'21"	22°23'00"					
	CS	996+55.25	297184.52	1256995.57								5°25'23"	210.00	209.81	6.62	
	ST	998+65.25	297342.12	1257134.23	N 43°08'59" E	129.16										
17A	TS	999+94.41	297436.35	1257222.56								0°09'00"	40.00	40.00	0.03	¾" 60/50
	SC	1000+34.41	297465.55	1257249.89			-7639.49	0°45'00"	259.68	2°14'51"	1°56'51"					
	CS	1002+94.09	297658.44	1257423.73								0°09'00"	40.00	40.00	0.03	
	ST	1003+34.09	297688.65	1257449.95	N 40°54'08" E	90.67										
17B	TS	1004+24.76	297757.19	1257509.32								0°09'00"	40.00	40.00	0.03	¾" 60/50
	SC	1004+64.76	297787.40	1257535.53			7639.49	0°45'00"	186.17	1°41'47"	1°23'47"					
	CS	1006+50.93	297926.29	1257659.50								0°09'00"	40.00	40.00	0.03	
	ST	1006+90.93	297955.76	1257686.55	N 42°35'54" E											

CONSULTANT		DATE
DESIGNED BY	J B BRENDEN	09-18-09
ENTERED BY	J B BRENDEN	09-18-09
CHECKED BY	B M WILLIAMS	09-18-09
PROJ. MGR.	D HOOK	09-18-09

ISSUE: NO. | DATE | BY | DESCRIPTION

BNSF APPROVALS: DEPARTMENT | SIGNATURE | DATE

HNTB — HNTB Corporation

BNSF RAILWAY

SOUND TRANSIT COMMUTER RAIL
SEATTLE TO EVERETT, WASHINGTON
GRADING AND STRUCTURES

TEMPORARY MAIN TRACK 1
PHASE 1 CONSTRUCTION AT WILLOW CREEK

DWG NO. SHEET OF SHEETS

18-SEP-2009 14:02
\\seaw00\jobs\28401.BNSF\05422_Edmonds\Redbook\08_TechProd\Resubmittal\Design\Temp MT1 at Willow Ck.dgn
jbrenden

SCHEDULE B

Inspection and Replacement Costs

DESCRIPTION	AMOUNT	NOTES
Capital cost	$78,400.	Invested in inflation-indexed US Treasury bonds @ 2% for 100 years.
Inspection & Replacement	$60,000.	$600. annual for 100 years
TOTAL CAPITAL & REPLACEMENT	**$138,400.**	

SCHEDULE C

9.4. Primary Contacts

Sound Transit: Ellie Ziegler
Senior Environmental Planner
401 South Jackson
Seattle, WA 98104-2826
ellie.ziegler@soundtransit.org

BNSF: Donald R. Omsberg
BNSF Manager Engineering
2454 Occidental Ave. S., Ste 2D
Seattle, WA 98134

9.5 Notice

Sound Transit: Ellie Ziegler
Senior Environmental Planner
401 South Jackson
Seattle, WA 98104-2826
ellie.ziegler@soundtransit.org

with a copy to the following:

Jordan Wagner
Legal Counsel
Sound Transit
401 South Jackson
Seattle, WA 98104-2826
wagnerj@soundtransit.org

BNSF: Walt Smith
General Director Commuter Construction
2454 Occidental Ave. S, Ste 2D
Seattle, WA 98134
Walter1.smith@bnsf.com

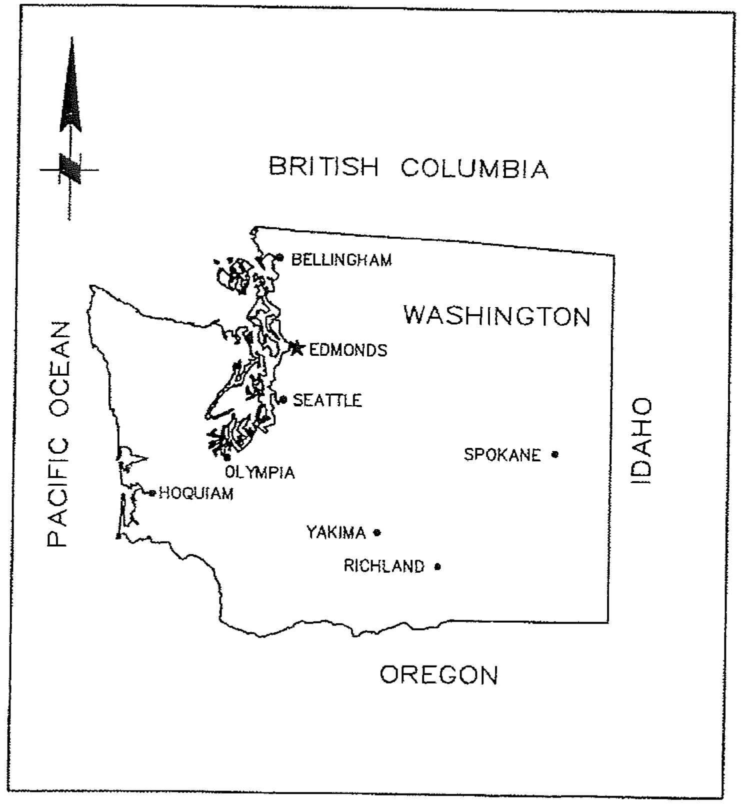
With copy to the following:

David Rankin
Senior General Attorney
2500 Lou Menk
Ft. Worth, TX 76131
David.rankin@bnsf.com

CITY OF EDMONDS

WILLOW CREEK OUTFALL PIPE EXTENSION

EDMONDS, WASHINGTON



LOCATION MAP
NTS

DRAWINGS LIST

SHEET NO.	DESCRIPTION
1	TITLE SHEET
2	EXISTING CONDITION SITE PLAN AND DEMOLITION
3	PLAN AND PROFILE
4	TYPICAL SECTIONS AND ELEVATION
5	PRECAST CONCRETE ANCHOR-PLAN, SECTIONS AND DETAILS
6	MISCELLANEOUS DETAILS

GENERAL NOTES:

1. STRUCTURAL DESIGN CRITERIA

A. CONCRETE

i. PRECAST & CAST-IN-PLACE, F'c = 5000 PSI

ii. REINFORCING STEEL, ASTM A615/A615M GRADE 60 (60,000 PSI).

B. STAINLESS STEEL BOLTS, WASHERS, AND NUTS, TYPE 316, ASTM F593.

2. EXISTING UTILITIES

UTILITIES AS SHOWN ARE BASED ON AVAILABLE INFORMATION. CONTRACTOR SHALL BE RESPONSIBLE FOR LOCATING ALL UTILITIES WITHIN THE PROJECT SITE. CHECK WITH APPROPRIATE AGENCIES THAT MAY HAVE UNDERGROUND FACILITIES WITHIN THE PROJECT SITE. CONTRACTOR SHALL BE SOLELY RESPONSIBLE FOR ANY DAMAGE TO UNDERGROUND FACILITIES RESULTING FROM CONTRACTORS OPERATION.

3. EXISTING WORK AND NEW WORK

CONTRACTOR SHALL VERIFY DIMENSIONS OF EXISTING WORK WHERE SUCH WORK CONNECTS TO OR AFFECTS NEW WORK. MATERIALS AND WORK SHOWN ON THESE DRAWINGS ARE NEW EXCEPT AS OTHERWISE INDICATED.

4. PERMITS CONFORMANCE REQUIREMENT

A. CONSTRUCTION SHALL CONFORM TO THE CONDITIONS AND REQUIREMENTS OF ALL PERMITS PROVIDED IN THE SPECIFICATIONS AND CONTRACT DOCUMENTS.

B. PROTECT EEL GRASS AND AVOID IMPACTS WHERE EVER PRACTICAL.

C. COMPLY WITH DEPARTMENT OF ECOLOGY STORM WATER MANUAL (LATEST EDITION) AND BEST MANAGEMENT PRACTICES.

5. SEQUENCE OF CONSTRUCTION

A. INSTALL NEW HDPE OUTFALL PIPE.

B. CUT OVER NEW OUTFALL PIPE TO EXISTING MANHOLE "A".

C. REMOVE ALL CMP.

6. EXISTING FEATURES

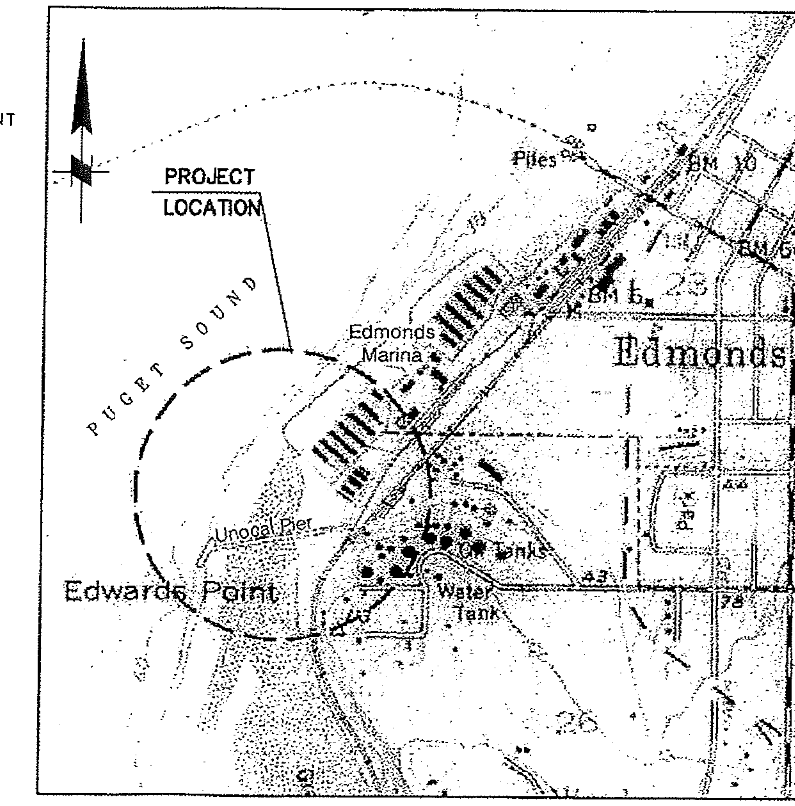
REMOVE DRIFTWOOD, LOGS, CONCRETE BLOCKS, ROCKS, BOULDERS, ANY OTHER MATERIAL AS NECESSARY TO CLEAR ACCESS TO/FROM PROJECT SITE. CONSTRUCT TEMPORARY RAMP AND DRIVEWAY AS NECESSARY. PROTECT IN PLACE AND/OR REPLACE IN KIND CATCH BASIN, CURB, PAVEMENT, SIGN, MONUMENT OR STRUCTURE AS PART OF THIS WORK.

7. ACCESS

REMOVE, SALVAGE, STORE, AND REPLACE ALL EXISTING SIGNS, BARBECUE STANDS, PICNIC TABLES, MONUMENTS, DRIFTWOOD, ECOLOGY BLOCKS, VOLLEY BALL POLES AND NET AND TRASH CANS IN APPROXIMATELY THE SAME LOCATION AS THEY WERE PRIOR TO CONSTRUCTION. PROVIDE IN TABULAR FORM THE QUANTITY AND LOCATION OF EACH FEATURE PRIOR TO MOBILIZING EQUIPMENT ONTO THE SITE.

ABBREVIATIONS

&	AND
@	AT
ACP	ASPHALT CONCRETE PAVEMENT
APPROX	APPROXIMATE
℄	CENTERLINE
CIP	CAST-IN-PLACE
CLR	CLEAR
CMP	CORRUGATED METAL PIPE
CONC	CONCRETE
DIA, ø	DIAMETER
DWG	DRAWING
(E)	EXISTING
EA	EACH
EF	EACH FACE
EL	ELEVATION
EQ	EQUAL
EW	EACH WAY
F'c	28-DAY COMPRESSIVE STRENGTH FOR CONCRETE
GALV	GALVANIZED
HDPE	HIGH DENSITY POLYETHYLENE
HORIZ	HORIZONTAL
ID	INSIDE DIAMETER
INV	INVERT
JT	JOINT
LF	LINEAR FEET (FOOT)
MAX	MAXIMUM
MHW	MEAN HIGH WATER
MHHW	MEAN HIGHER HIGH WATER
MIN	MINIMUM
MLLW	MEAN LOWER LOW WATER
(N)	NEW
NTS	NOT TO SCALE
OC	ON CENTER
OD	OUTSIDE DIAMETER
ℙ	PLATE
REINF	REINFORCED, REINFORCING
REQD	REQUIRED
SIM	SIMILAR
SPECS	SPECIFICATION
STD	STANDARD
TYP	TYPICAL
UON	UNLESS OTHERWISE NOTED
USCGS	U.S. COAST & GEODETIC SURVEY
VERT	VERTICAL
WSDOT	WASHINGTON STATE DEPARTMENT OF TRANSPORTATION



VICINITY MAP
NTS

CROSS-REFERENCE LEGEND

ADDITIONAL SHEET WHERE REFERENCED — XX
SECTION OR DETAIL IDENTIFICATION, SEE NOTE — A
REFERENCE SHEET ON WHICH SECTION OR DETAIL IS TAKEN
REFERENCE SHEET ON WHICH SECTION OR DETAIL IS SHOWN

NOTE: LETTER INDICATES SECTION, NUMBER INDICATES DETAIL. WHERE THERE IS NO REFERENCE SHEET INDICATED, IT MEANS THE DETAIL OR SECTION IS TAKEN AND SHOWN ON THE SAME SHEET.

FOR REFERENCE

Moffatt & Nichol
710 SECOND AVENUE, SUITE 720
SEATTLE, WA 98104

ENGINEERING DIVISION
121 FIFTH AVENUE NORTH
EDMONDS, WASHINGTON 98020
(425) 771-0220

APPROVED BY: CITY ENGINEER — DATE

	BY	DATE
DESIGN	JFJ	2004
DRAWN	AB/MO	8/6/04
CHECKED	JFJ/MPH	9/6/04
APPROVED	TJM	

NO.	DATE	BY	REVISION

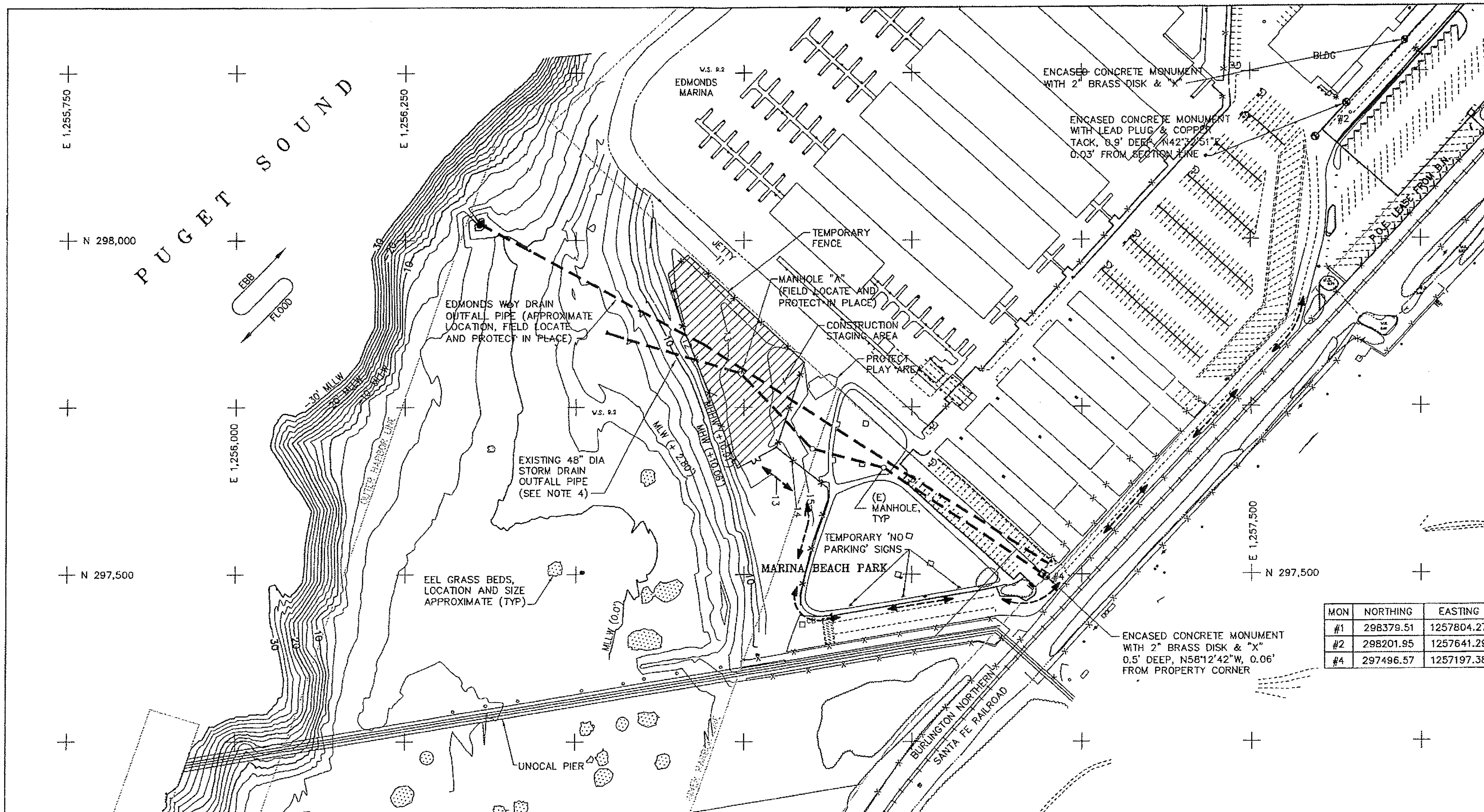
WILLOW CREEK OUTFALL PIPE EXTENSION

TITLE SHEET

H. SCALE
V. SCALE
SHEET 1
1 OF 6 SHEETS
JOB NO. 4991

Plotted: Dec 13, 2004 - 1:19pm

File: P:\4991 - Willow Creek Outfall\CADD\Submittals\100%_Sub\4991001001.dwg



MON	NORTHING	EASTING
#1	298379.51	1257804.27
#2	298201.95	1257641.29
#4	297496.57	1257197.38

SITE PLAN

SCALE: 1' = 80'

NOTES:

1. VERTICAL DATUM = MEAN LOWER LOW WATER. BENCHMARK = USC&GS BRASS CAP MONUMENT, "TIDAL 9," AT SW CORNER OF PORT OF EDMONDS YACHT CLUB BUILDING. ELEVATION = 15.67 FEET.
2. HORIZONTAL DATUM: WASHINGTON PLANE COORDINATES, NAD83 (1991).
3. TOPOGRAPHIC MAP AND CONTOUR LINES BELOW ELEVATION 10.0 FT WERE BASED ON TOPOGRAPHIC SURVEY CONDUCTED ON 5/30/01 BY REID MIDDLETON, INC. IN THE NW 1/4, SECTION 26, T27N., R3E., WM EDMONDS, SNOHMISH COUNTY, WASHINGTON. CONTOUR LINES ABOVE ELEVATION 10.0 FT WERE APPROXIMATED BASED ON TOPOGRAPHIC MAP PROVIDED BY THE CITY OF EDMONDS (SURVEY BY A. L. CHRISMAN, DATES: 7/9/02, 11/20/02, AND 4/9/03).
4. DEMOLISH AND REMOVE EXISTING 48" DIA (CMP) BURIED OUTFALL. FROM THE LAST MANHOLE (MANHOLE "A") TO THE OUTBOARD END OF THE PIPE, (APPROXIMATELY 200 FT LONG) BACKFILL THE EXCAVATION TRENCH (FOR PIPE REMOVAL), AND RESTORE THE FINISH SURFACE TO PRE-CONSTRUCTION CONDITION. EXISTING PIPE IS CORRUGATED METAL WITH CONCRETE ANCHORS AND HAS ASBESTOS-BONDED ASPHALT COATING.
5. CONTRACTOR ACCESS ROUTE IS LIMITED TO THAT SHOWN ON THIS DRAWING, AS DESCRIBED IN THE SPECIFICATIONS, AND THE FOLLOWING:
   A. ALONG THE EXISTING OUTFALL PIPE TO BE REMOVED
   B. ALONG THE ALIGNMENT OF THE NEW OUTFALL PIPE EXTENSION
   C. ALONG THE NORTH SIDE AND PARALLEL TO THE UNOCAL PIER.
   THE AREA BETWEEN THE NEW OUTFALL PIPE AND THE UNOCAL PIER SHALL NOT BE USED FOR ANY CONSTRUCTION ACTIVITY. CONTRACTOR SHALL COMPLY WITH THE CITY OF EDMONDS TRAFFIC CONTROL REQUIREMENTS.
6. SURVEY EXISTING AND FINAL OUTFALL ALIGNMENT INCLUDING FINISHED GRADE AND INVERT ELEVATIONS. PROVIDE BEARING AND DISTANCE. SURVEY SHALL BE PERFORMED BY A LICENSED SURVEYOR REGISTERED IN WASHINGTON STATE.

FOR REFERENCE

GRAPHIC SCALE (IN FEET)

80 0 80 160

1" = 80'

LEGEND:

- RAILROAD TRACK
- CONTRACTOR ACCESS ROUTE
- FENCE
- CONSTRUCTION STAGING AREA

Moffatt & Nichol
710 SECOND AVENUE, SUITE 720
SEATTLE, WA 98104

WILLOW CREEK OUTFALL PIPE EXTENSION

EXISTING CONDITION SITE PLAN AND DEMOLITION

ENGINEERING DIVISION
121 FIFTH AVENUE NORTH
EDMONDS, WASHINGTON 98020
(425) 771-0220

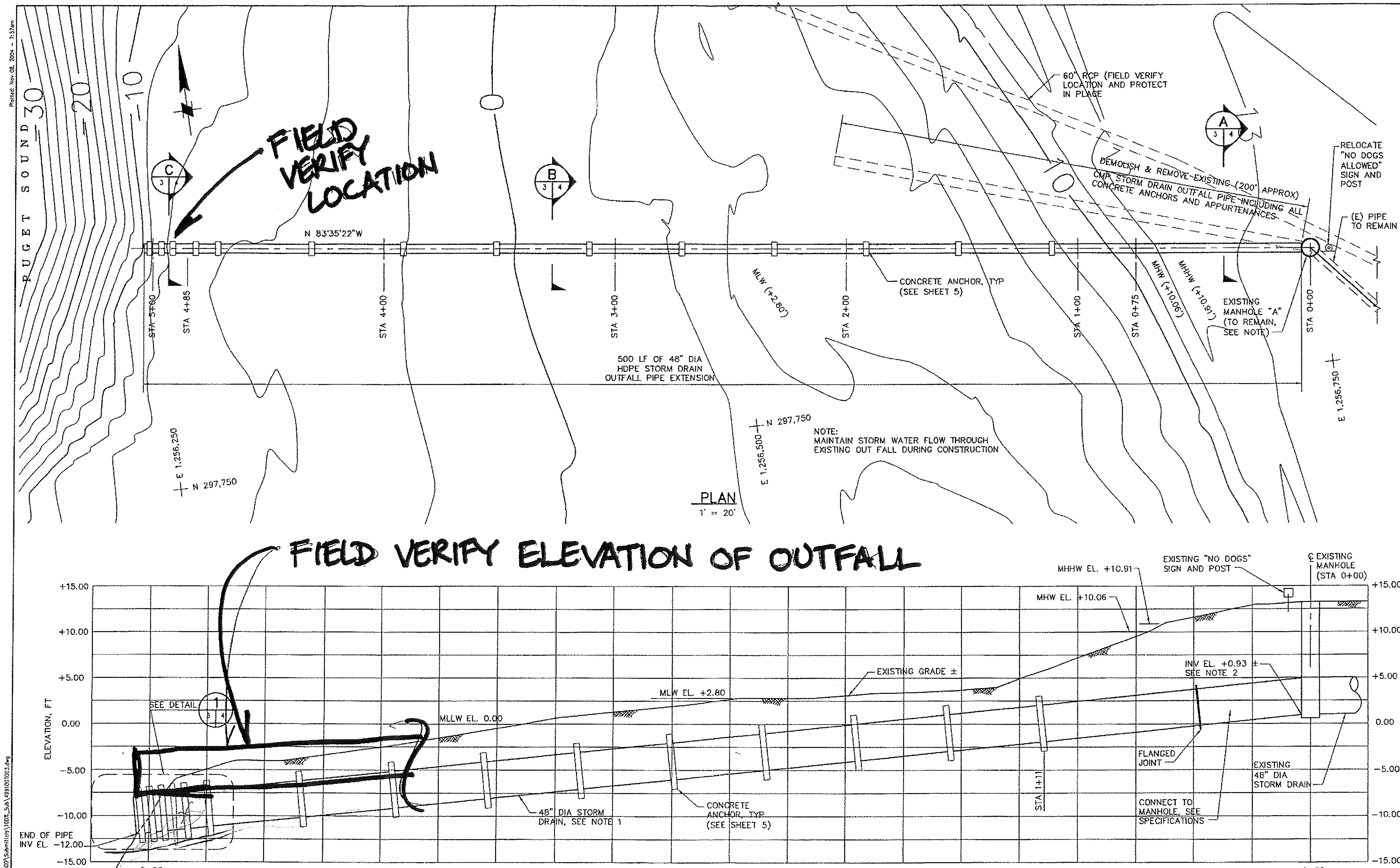
APPROVED BY
CITY ENGINEER
DATE

	BY	DATE
DESIGN	JFJ	2004
DRAWN	AB/MO	8/6/04
CHECKED	JFJ/APH	8/6/04
APPROVED	TJM	

SHEET 2

2 OF 6 SHEETS

JOB NO. 4991



NOTES:

1. STORM DRAIN PIPE SHALL HAVE A UNIFORM SLOPE FROM THE EXISTING MANHOLE TO THE OUTBOARD END OF PIPE. DREDGED BOTTOM SHALL BE SMOOTH TO MATCH THE UNIFORM SLOPE OF THE PIPE.
2. CONTRACTOR SHALL VERIFY AND MATCH THE EXISTING INVERT OF THE PIPE AT THE MANHOLE. INVERT ELEVATION SHOWN IS APPROXIMATE ONLY.

PROFILE
1' = 20' HORIZ
1' = 5' VERTICAL

GRAPHIC SCALES (IN FEET)
1" = 5'
1" = 20'

FOR REFERENCE

Moffatt & Nichol
710 SECOND AVENUE, SUITE 720
SEATTLE, WA 98104

ENGINEERING DIVISION
121 FIFTH AVENUE NORTH
EDMONDS, WASHINGTON 98020
(425) 771-0220

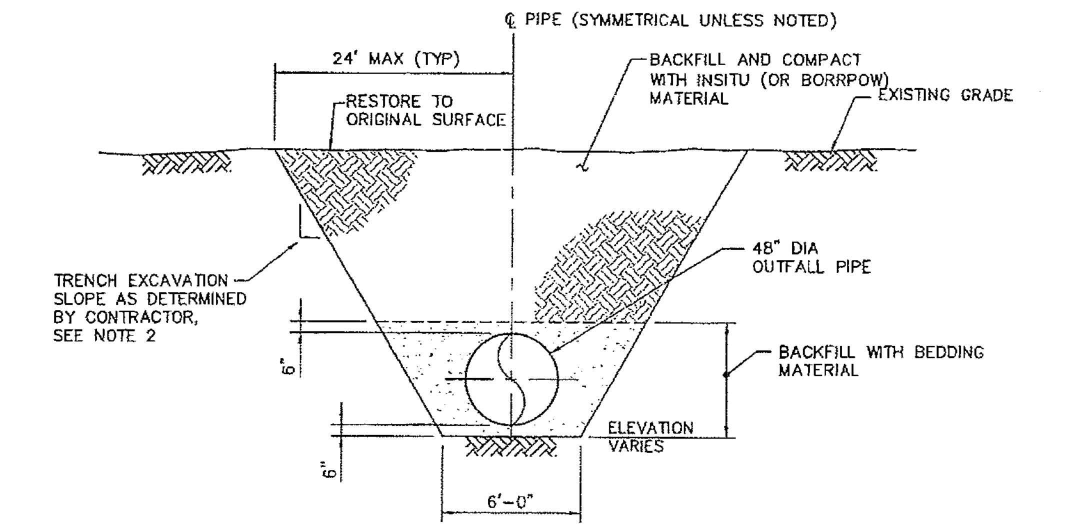
WILLOW CREEK OUTFALL PIPE EXTENSION
PLAN AND PROFILE

APPROVED BY: CITY ENGINEER

	BY	DATE
DESIGN	JFJ	2004
DRAWN	AB/MO	8/8/04
CHECKED	JFJ/MPH	9/8/04
APPROVED	TJM	

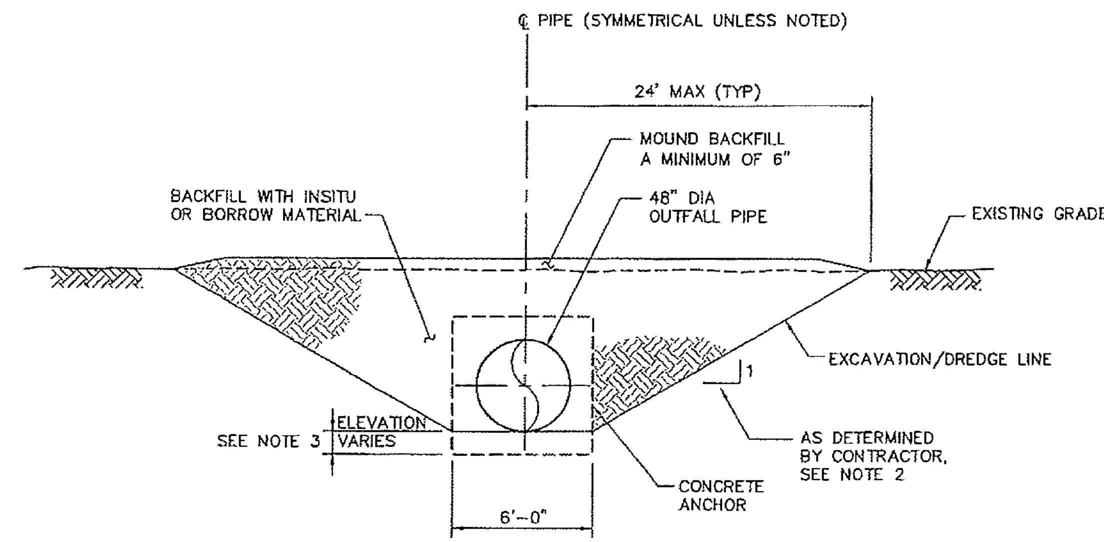
SHEET 3
3 OF 6 SHEETS
NO. 4991

Plotted: Nov 08, 2004 - 7:57am
File: P:\4991 - Willow Creek Outfall\CADD\Submittals\100%_Sub\4991D01003.dwg



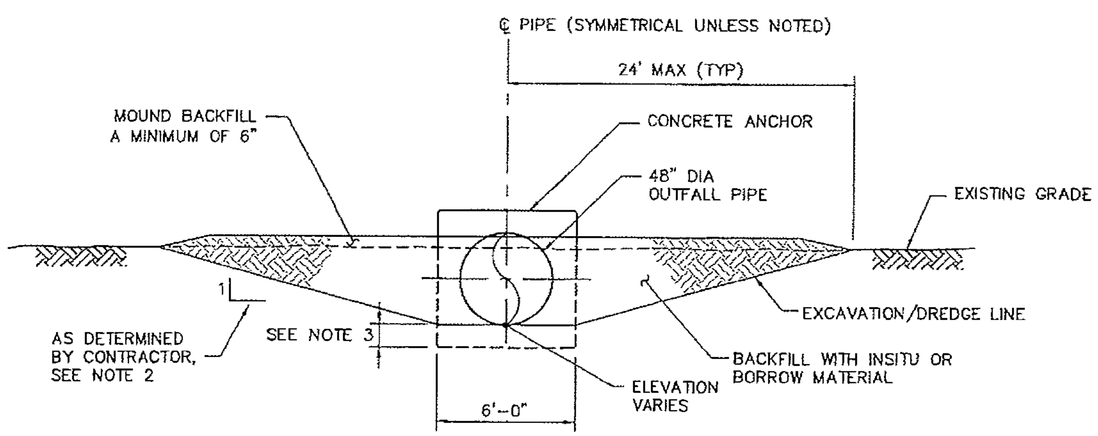
STATION 0+00 TO STATION 0+75±
(OR WHERE EXISTING GRADE IS ABOVE MHW)

TYPICAL SECTION A 3|4
1/4" = 1'-0"



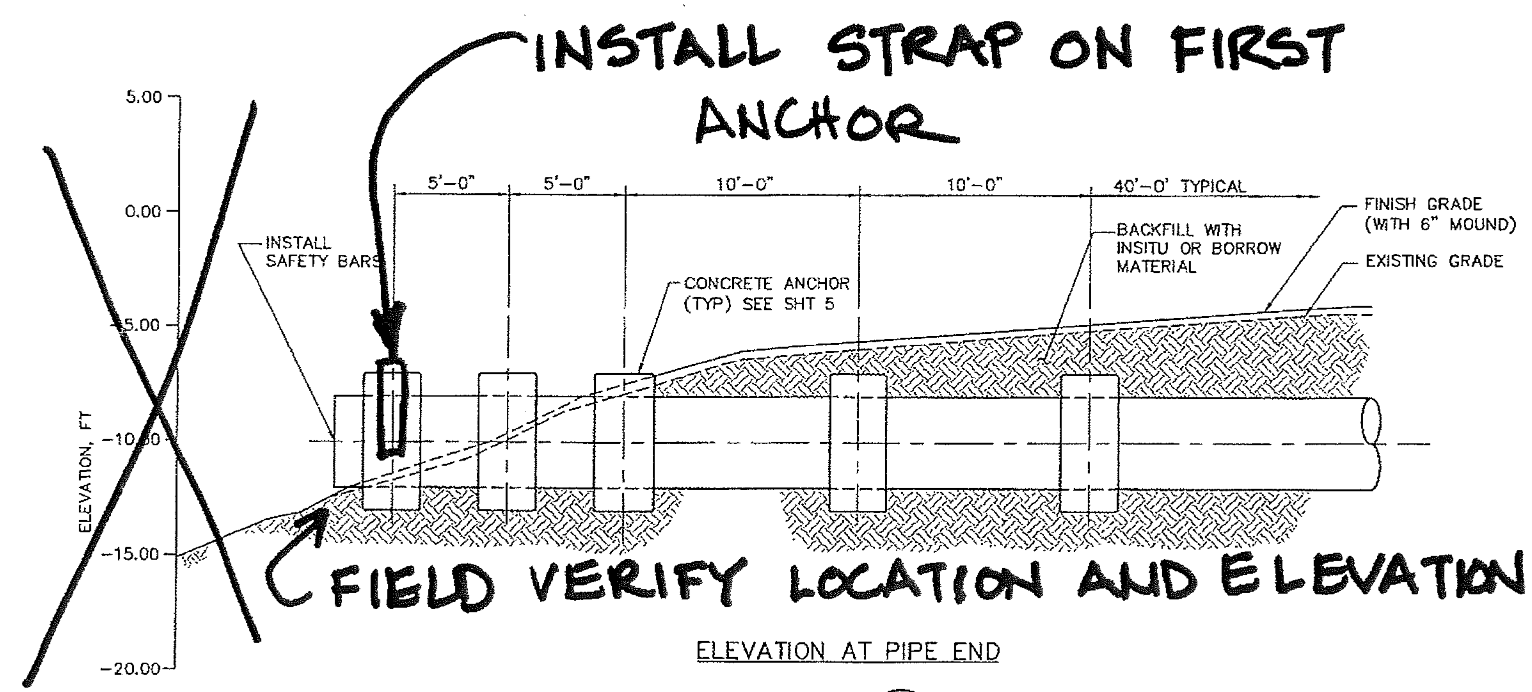
STATION 0+75± TO STATION 4+85±

TYPICAL SECTION B 3|4
1/4" = 1'-0"



STATION 4+85± TO OUTBOARD END OF PIPE

TYPICAL SECTION C 3|4
1/4" = 1'-0"



ELEVATION AT PIPE END

DETAIL 1 3|4
1/4" = 1'-0"

FOR REFERENCE

NOTES:

1. DREDGED/EXCAVATED MATERIALS MAY BE PLACED TEMPORARILY ALONG SIDE OF THE PIPELINE AT CONTRACTORS RISK.
2. DO NOT EXCEED 24' MAX. EXCAVATION LIMITS. PROVIDE SHORING OR OTHER APPROPRIATE MEANS AND METHODS AS REQUIRED TO MAINTAIN AN OPEN TRENCH.
3. EXCAVATE AT ANCHOR LOCATIONS AS NECESSARY TO MAINTAIN CONSTANT SLOPE IN PIPE.

GRAPHIC SCALE
2 0 2 4 6
1/4" = 1'-0"

Moffatt & Nichol
710 SECOND AVENUE, SUITE 720
SEATTLE, WA 98104

DESIGN	JFJ	2004
DRAWN	AB	8/6/04
CHECKED	JFJ/MPH	8/6/04
APPROVED	TJM	

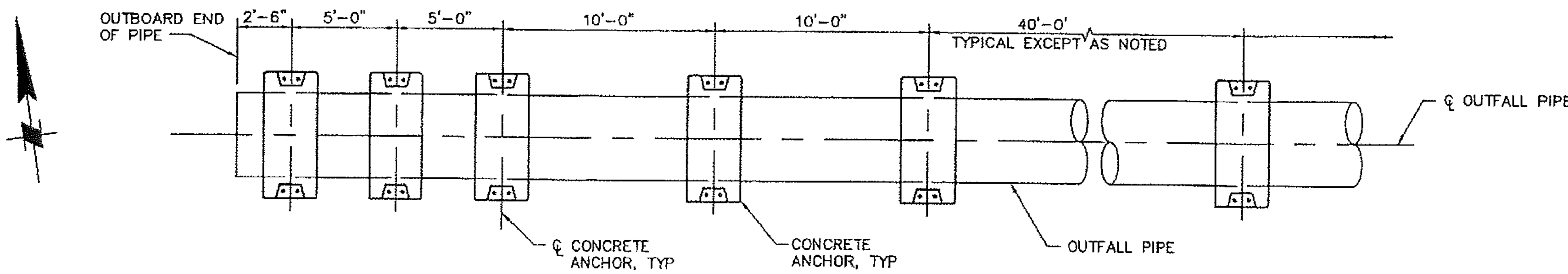
APPROVED BY
CITY ENGINEER
DATE

ENGINEERING DIVISION
121 FIFTH AVENUE NORTH
EDMONDS, WASHINGTON 98020
(425) 771-0220

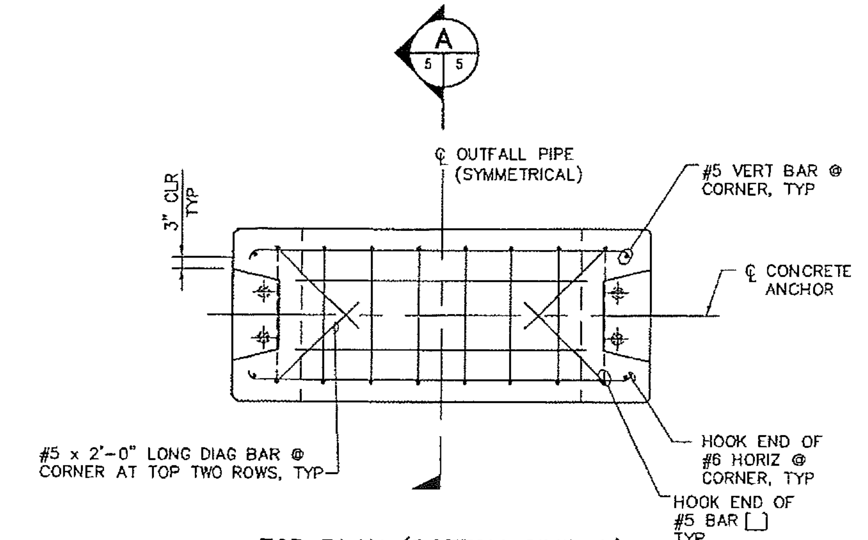
WILLOW CREEK OUTFALL PIPE EXTENSION

TYPICAL SECTIONS AND ELEVATION

SHEET 4
4 OF 6 SHEETS
JOB NO. 4991

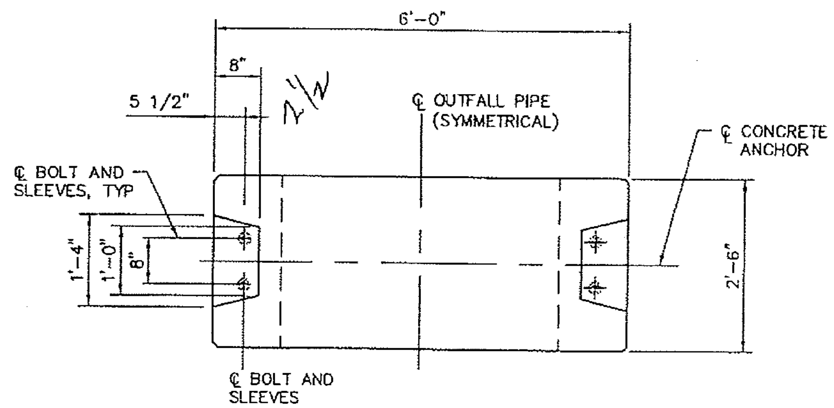


PARTIAL PLAN
1/4" = 1'-0"



TOP PLAN (BOTTOM SIMILAR)

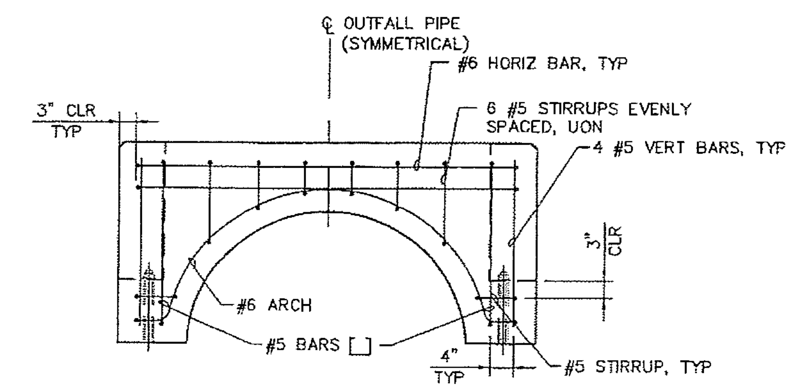
DETAIL – REINFORCEMENT 1 (5 | 5)
3/4" = 1'-0"



PLAN
3/4" = 1'-0"

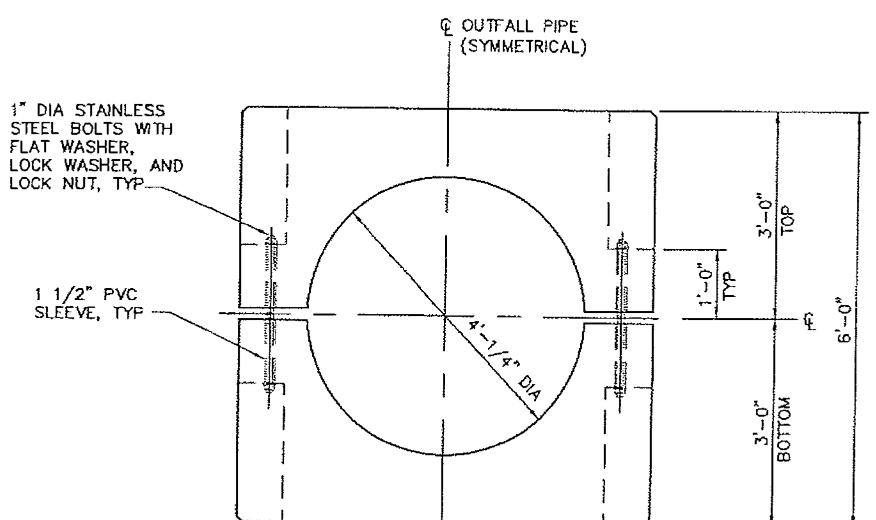
NOTES:

1. ALL EXPOSED CONCRETE EDGES SHALL BE CHAMFERED 1 INCH UNLESS OTHERWISE NOTED.
2. PROVIDE 1/8 INCH THICK BLACK RUBBER SHEET OR NEOPRENE PADDING AROUND THE PIPE AT CONCRETE ANCHOR LOCATIONS. WIDTH OF SHEET OR PADDING SHALL BE 2 INCHES WIDER THAN THE CONCRETE TO PREVENT DIRECT CONTACT BETWEEN THE PIPE AND THE CONCRETE ANCHORS.
3. TOLERANCE FOR LOCATION OF PVC SLEEVE AS INDICATED IS 1/8 INCH MAX.

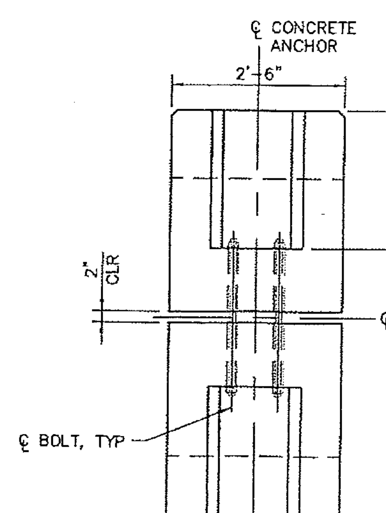


SECTION

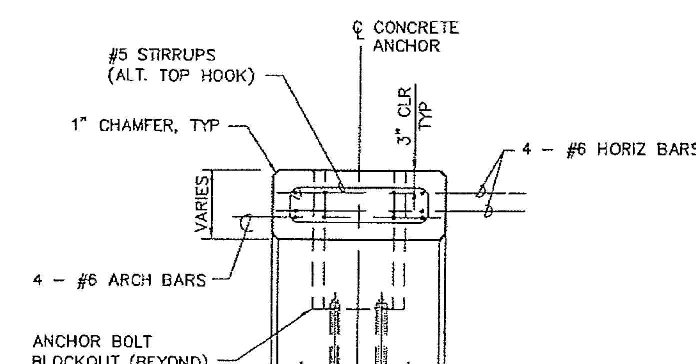
DETAIL – REINFORCEMENT 2 (5 | 5)
3/4" = 1'-0"



ELEVATION
3/4" = 1'-0"



SIDE ELEVATION
3/4" = 1'-0"



SECTION A (5 | 5)
3/4" = 1'-0"

FOR REFERENCE

GRAPHIC SCALE
1 0 1 2 3 4
3/4" = 1'-0"

Moffatt & Nichol
710 SECOND AVENUE, SUITE 720
SEATTLE, WA 98104

WILLOW CREEK OUTFALL PIPE EXTENSION
PRECAST CONCRETE ANCHOR
PLAN, SECTION & DETAILS

ENGINEERING DIVISION
121 FIFTH AVENUE NORTH
EDMONDS, WASHINGTON 98020
(425) 771-0220

	BY	DATE
DESIGN	JFJ	2004
DRAWN	AB, EP	8/6/04
CHECKED	JFJ/MPH	8/6/04
APPROVED	TJM	

NO.	DATE	BY	REVISION

APPROVED BY
CITY ENGINEER
DATE

H. SCALE
V. SCALE
SHEET 5
5 OF 6 SHEETS
JOB NO. 4991

Plotted: Dec 13, 2004 - 1:20pm
File: P:\4991 - Willow Creek Outfall\CADD\Submittals\100%_Sub\4991C07005.dwg

APPENDIX C

UNOCAL – ECOLOGY REMEDIATION AND CLEANUP COMMUNICATIONS

Dave Cline

From:	South, David (ECY) [DSOU461@ECY.WA.GOV]
Sent:	Wednesday, May 08, 2013 4:31 PM
To:	Dave Cline
Cc:	Zorn, Scott; Kim Jolitz (kjolitz@chevron.com)
Subject:	Unocal Edmonds - Willow Creek Sediments
Attachments:	Unocal Edmonds - Willow Creek Cleanup.pdf

I have spent some time going through the file to dig out the sediment data. Data were collected in 1996, 2003, and 2012.

The best description of the 1996 and 2003 work is in Agreed Order 4460 for the Interim Actions conducted in 2008. This can be found at Ecology's Unocal Edmonds website. Click on Electronic Documents in the right sidebar and, under Group Legal open the Agreed Order of 7/05/2007. Review Exhibit B, Section 3.5. The 2012 sampling was conducted to further assess the upstream sample.

The attached shows the sediment sampling locations, which I have compiled onto on page, and the area of Willow Creek that required cleanup. This cleanup was completed in 2008. The figure showing the part of the creek that was cleaned up is from the Phase II Remedial Implementation As-built Report, dated January 18, 2010. Note that sediment samples were collected from where Willow Creek enters the Tidal Basin upstream to about where the creek enters the property.

Additional samples were collected in 2012 to further assess the failure of the most upstream location. These samples indicated cleanup was not necessary in this stretch of the creek.

I have additional detail, but it gets a little confusing because work was done and revisited on several years and several sampling round to identify the area being cleaned up. However, I can send you a package if you want.

Here is a rewrite of your paragraph (Chevron may wish to chime in on this):

> Recent communications with Chevron and the Washington State Department of Ecology indicate that sediment sampling was conducted in Willow Creek from the tidal basin to approximately the upstream point where the Willow Creek enters Unocal property. The sampling identified that a stretch of Willow Creek northwest of the site required cleanup. This cleanup was completed as part of Interim Actions conducted in 2008.
>
> Most contamination has been removed from the site, but some impacts remain. If Ecology believes additional sampling is needed to assess whether contaminant migration may have impacted sediments subsequent to the 2008 sediment cleanup, such sampling would be included in the Compliance Monitoring Plan for the site.

Currently Chevron and ARCADIS are preparing a draft Feasibility Study. The draft is due to Ecology on December 27th, 2013. Ecology will be working with Chevron and ARCADIS in 2014 to finalize the Feasibility Study, select a cleanup action, and prepare a draft Cleanup Action Plan. The Cleanup Action Plan will not be finalized until after Ecology receives public comment.

Please contact me if you have any questions.

David L. South
Senior Engineer
Washington State Dept. of Ecology
Toxics Cleanup Program, NWRO
3190 160th Avenue SE
Bellevue, WA 98008-5452
425-649-7200

From: Dave Cline [mailto:DRC@shanwil.com]
Sent: Wednesday, May 08, 2013 10:35 AM
To: South, David (ECY)
Subject: Unocal Edmonds Fuel Terminal - Willow Creek Sediments

David,

Thank you for taking time to talk with me today about the Unocal Edmonds and Willow Creek site. The City of Edmonds and Earthcorps (since People for Puget Sound has folded), are completing an early feasibility study for daylighting Willow Creek to the south through the BNSF bridges and Marina Beach Park.

Would you be able to provide a statement regarding the status and current needs for cleanup of Willow Creek sediments? Also, is there any remaining ground to surface water contamination risks for Willow Creek?

Information provided by Chevron and their consultant Arcadis only focused on the recent outfall cleanup at the east end of the detention pond. Per our conversation today, you indicated that a complete set of sampling and cleanup actions in Willow Creek had been performed. More information and references to studies and a statement by Ecology on the status of Willow Creek sediments would be helpful.

Here is a paragraph I was working on in our report. You can feel free to modify/correct, or provide other language and references.

"Recent communications with Chevron and the Washington State Department of Ecology have confirmed that Willow Creek sediment cleanup remedial activities have been completed and sediment sampling indicates that sediment quality is within regulatory standards and does not require further action."

Thank you for your input.

Dave Cline

SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

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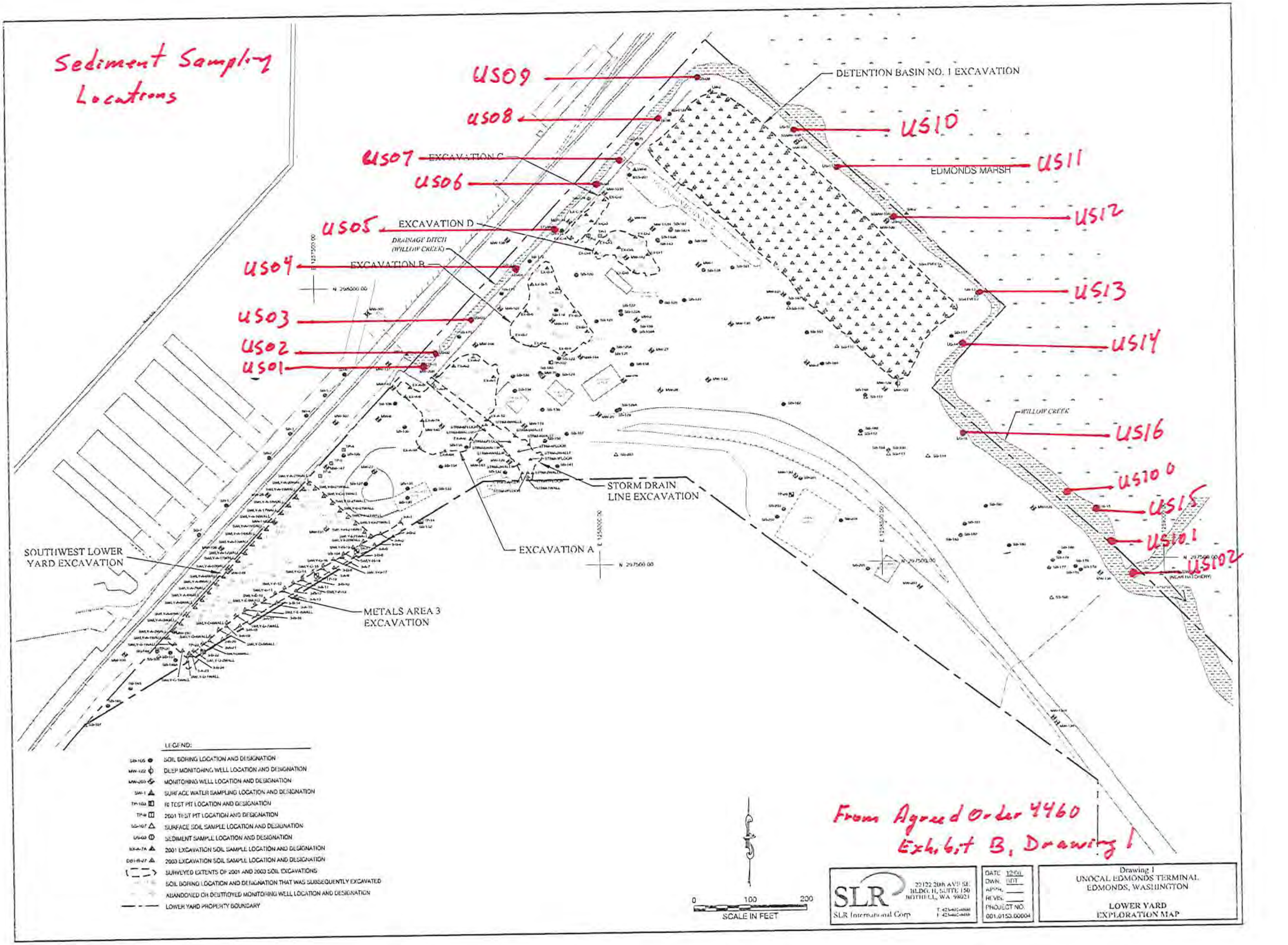
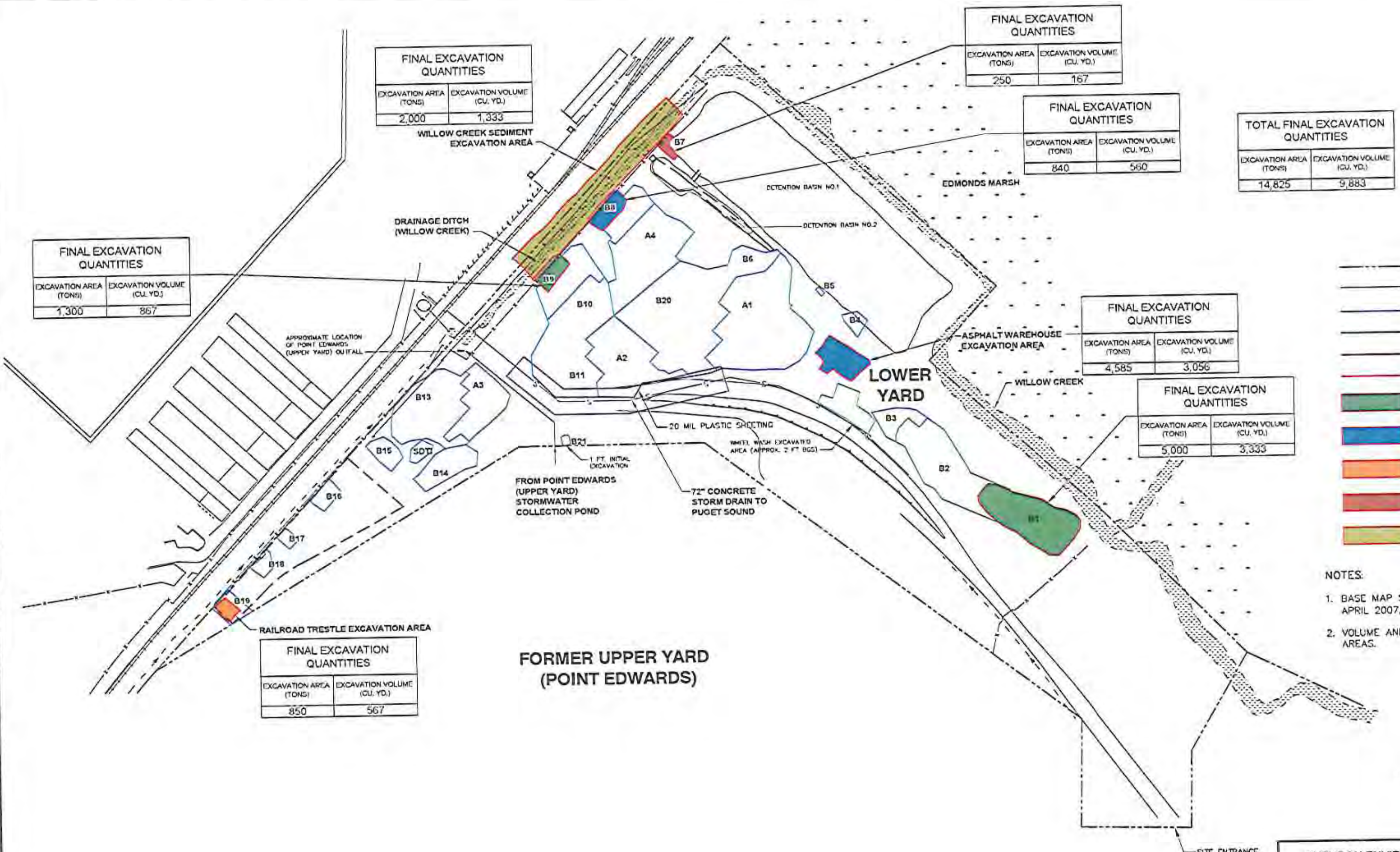


Sediment Sampling Locations
US09
US08
US07
US06
US05
US04
US03
US02
US01
US10
US11
US12
US13
US14
US16
US100
US15
US101
US102
DETENTION BASIN NO. 1 EXCAVATION
EDMONDS MARSH
WILLOW CREEK
EXCAVATION C
EXCAVATION D
DRAINAGE DITCH (WILLOW CREEK)
EXCAVATION B
EXCAVATION A
STORM DRAIN LINE EXCAVATION
SOUTHWEST LOWER YARD EXCAVATION
METALS AREA 3 EXCAVATION
N 298000.00
N 297500.00
LEGEND:
SOIL BORING LOCATION AND DESIGNATION
DEEP MONITORING WELL LOCATION AND DESIGNATION
MONITORING WELL LOCATION AND DESIGNATION
SURFACE WATER SAMPLING LOCATION AND DESIGNATION
RI TEST PIT LOCATION AND DESIGNATION
2001 TEST PIT LOCATION AND DESIGNATION
SURFACE SOIL SAMPLE LOCATION AND DESIGNATION
SEDIMENT SAMPLE LOCATION AND DESIGNATION
2001 EXCAVATION SOIL SAMPLE LOCATION AND DESIGNATION
2003 EXCAVATION SOIL SAMPLE LOCATION AND DESIGNATION
SURVEYED EXTENTS OF 2001 AND 2003 SOIL EXCAVATIONS
SOIL BORING LOCATION AND DESIGNATION THAT WAS SUBSEQUENTLY EXCAVATED
ABANDONED OR DESTROYED MONITORING WELL LOCATION AND DESIGNATION
LOWER YARD PROPERTY BOUNDARY
0
100
200
SCALE IN FEET
From Agreed Order 4460
Exhibit B, Drawing 1
SLR
22122 20th AVE SE
BLDG. H, SUITE 150
BOTHELL, WA 98021
SLR International Corp
DATE 12/06
PROJECT NO. 001.0153.00004
Drawing 1
UNOCAL EDMONDS TERMINAL
EDMONDS, WASHINGTON
LOWER YARD
EXPLORATION MAP



LEGEND:

- LOWER YARD SITE BOUNDARY
- DRAINAGE DITCH
- PHASE I EXCAVATION AREAS
- SHALLOW PHASE I EXCAVATION AREA
- WSDOT STORMWATER LINE AREA
- PHASE II EXCAVATION AREAS
- FINAL EXTENTS OF SOIL EXCAVATION (APPROXIMATELY 12' BGS)
- FINAL EXTENTS OF SOIL EXCAVATION (APPROXIMATELY 10' BGS)
- FINAL EXTENTS OF SOIL EXCAVATION (APPROXIMATELY 6' BGS)
- FINAL EXTENTS OF SOIL EXCAVATION (APPROXIMATELY 5' BGS)
- FINAL EXTENTS OF SEDIMENT REMOVAL (APPROXIMATELY 1' BGS)

NOTES:

1. BASE MAP SUPPLIED BY SLR INTERNATIONAL CORP., APRIL 2007, AT A SCALE OF 1"=150'.
2. VOLUME AND AREA DATA CORRESPOND TO SHADED AREAS.

CHEVRON ENVIRONMENTAL MANAGEMENT COMPANY
FORMER UNOCAL EDMONDS TERMINAL
EDMONDS, WASHINGTON

PHASE II FINAL EXCAVATION AREAS AND VOLUMES

ARCADIS

FIGURE 10

Dave Cline

From:	Zorn, Scott [Scott.Zorn@arcadis-us.com]
Sent:	Tuesday, May 07, 2013 5:10 PM
To:	Dave Cline; Jolitz, Kim S; Shuster, Jerry
Cc:	Keeley O'Connell (Keeley@earthcorps.org); Boortz, Marielle (MJBoortz); Giseburt, Michael S.
Subject:	RE: DRAFT: Willow Creek Daylight Early Feasibility Study
Attachments:	Unocal Edmonds - review of sediment results

Dave,

Thank you for addressing our comments. We truly appreciate having an opportunity to review and comment.

As per the comments below. We have no issue with your opinion on the tide gates and drainage system. Pertaining to the second item, I have attached our email correspondence with our Ecology project manager, David South, regarding sediments in Willow Creek as relating to the former Unocal Edmonds Terminal and our remedial efforts. Please let me know if you need any additional information regarding this matter.

Thank you,
Scott

From: Dave Cline [mailto:DRC@shanwil.com]
Sent: Monday, May 06, 2013 6:02 PM
To: Jolitz, Kim S; Shuster, Jerry
Cc: Keeley O'Connell (Keeley@earthcorps.org); Zorn, Scott; Boortz, Marielle (MJBoortz); Giseburt, Michael S.
Subject: RE: DRAFT: Willow Creek Daylight Early Feasibility Study

Kim,

Please find attached the proposed revisions to the Willow Creek Daylight Early Feasibility Study that were made based on your comments provided today. In general, I have been able to address your comments except for two instances.

The first instance is the operation of the partially closed gates and pipes located at the downstream end of the Willow Creek channel. I understand there is question about the ownership of these gates, and we have revised the report to reflect this understanding. There is a statement/request in your comments about the pipes being restrictions on flow in the Willow Creek system and that this statement should be removed from the report (Section 2.4.3 – 1st paragraph, page 10). It is our opinion that these partially closed gates and pipes are a constriction in the Willow Creek drainage system and that the proposed project would benefit and have improved drainage resulting from their removal. We plan on keeping this text in our report unless there is some information we are missing about the pipe/gate system.

The second item that I was not able to reconcile is the statement in Section 2.5.4 – 1st paragraph, page 15 that "…the Department of Ecology has determined that sediments in Willow Creek do not contain concentrations of contaminants of concern associated with Unocal's former operation within the sediments of Willow Creek." I am not familiar with each and every study and data collection effort for the Unocal site. Can you direct me and provide a reference that supports this statement so that we may consider inclusion of this information in our report with a valid reference?

Thank you for your input and clarifications to the report.

Dave Cline

SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

David Cline, PE WA | **Senior Associate**
400 N. 34th St., Suite 100
Seattle, WA 98103-8636
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Direct: (206) 695-6885
drc@shanwil.com www.shannonwilson.com

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From: Jolitz, Kim S [mailto:kjolitz@chevron.com]
Sent: Monday, May 06, 2013 7:38 AM
To: Shuster, Jerry
Cc: Dave Cline; Keeley O'Connell (Keeley@earthcorps.org); Zorn, Scott; Boortz, Marielle (MJBoortz)
Subject: RE: DRAFT: Willow Creek Daylight Early Feasibility Study

Jerry,

Thank you for giving us the opportunity to submit comments on the draft Early Feasibility Study for Willow Creek Daylighting dated April 12, 2013. Attached is the word document version you provided to us marked, by using the track changes feature, with our comments and requested changes. Please note that our comments are limited to addressing specific factual information as it relates to the former Unocal Edmonds Fuel Terminal site.

We have two general comments, which we also have noted in the attached mark-up:

The former terminal site should be described as “Unocal”, rather than “Unocal/Chevron” as a global change in the document (including captions on photographs, notations on figures, attachments, appendices, etc.) because the site is owned by Union Oil Company of California (Unocal).

In addition, as noted in reports sent by/on behalf of Unocal to Washington State Department of Ecology, the site has been extensively remediated and the extent of any remaining contamination at the site is known and has been characterized. Therefore comments in the document that speculate about the environmental condition of, and potential for, future impacts from the former terminal site should be deleted.

Please let me know if you have any questions.

Thank you,
Kim

Kim Jolitz
Project Manager
Chevron Environmental Management Company
6101 Bollinger Canyon Road
San Ramon, CA 94583
Tel (925) 790-3946
Fax (925) 790-6772
Cell (925) 487-3584
kjolitz@chevron.com

From: Shuster, Jerry [mailto:Jerry.Shuster@edmondswa.gov]
Sent: Tuesday, April 30, 2013 11:09 AM
To: Jolitz, Kim S
Cc: Dave Cline; Keeley O'Connell (Keeley@earthcorps.org)
Subject: RE: DRAFT: Willow Creek Daylight Early Feasibility Study

OK, May 6 will work.

--Jerry

From: Jolitz, Kim S [mailto:kjolitz@chevron.com]
Sent: Tuesday, April 30, 2013 11:04 AM
To: Shuster, Jerry
Cc: Dave Cline
Subject: FW: DRAFT: Willow Creek Daylight Early Feasibility Study

Jerry,
We can meet the May 6 deadline, but May 1 is problematic. We would like to provide a thorough review and have the report accurately reflect conditions at our site. Please confirm the May 6 deadline for our comments.
Thank you,
Kim

From: Dave Cline [mailto:DRC@shanwil.com]
Sent: Friday, April 26, 2013 3:24 PM
To: Jolitz, Kim S; Shuster, Jerry
Cc: Keeley O'Connell (Keeley@earthcorps.org); Williams, Phil
Subject: RE: DRAFT: Willow Creek Daylight Early Feasibility Study

Kim,

I have attached a Word version of the DRAFT Willow Creek Daylight – Early Feasibility Study. The document is provided to you with the understanding that the information contained in the report is in DRAFT form, and for the exclusive use by the City of Edmonds for the stated project.

We look forward to your comments and appreciate your interest in helping us finalize and improve information in the report.

Let me know if you have any questions. It would be helpful to have your comments by May 1st, as we are trying to finalize and redistribute the report the following week.

Have a good weekend.
Dave

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From: Jolitz, Kim S [mailto:kjolitz@chevron.com]
Sent: Friday, April 26, 2013 12:44 PM
To: Shuster, Jerry
Cc: Keeley O'Connell (Keeley@earthcorps.org); Dave Cline; Williams, Phil
Subject: RE: DRAFT: Willow Creek Daylight Early Feasibility Study

Jerry,
Would it be possible to get a copy of the report in Microsoft Word to make comments we submit a little clearer?
Thanks,
Kim

From: Shuster, Jerry [mailto:Jerry.Shuster@edmondswa.gov]
Sent: Monday, April 22, 2013 1:47 PM
To: Jolitz, Kim S
Cc: Keeley O'Connell (Keeley@earthcorps.org); Dave Cline; Williams, Phil
Subject: RE: DRAFT: Willow Creek Daylight Early Feasibility Study

Kim,
If you can get comments to me by May 6th, we can make any necessary corrections.
Thanks,
-Jerry

From: Jolitz, Kim S [mailto:kjolitz@chevron.com]
Sent: Monday, April 22, 2013 1:09 PM
To: Shuster, Jerry
Cc: Scott.Zorn@arcadis-us.com
Subject: RE: DRAFT: Willow Creek Daylight Early Feasibility Study

Jerry,
Thank you for sending this to us. Although I have not finished reading it I can tell that there will be a few things we would like the opportunity to have corrected. What is your timing on this?
Kim

Kim Jolitz
Project Manager
Chevron Environmental Management Company
6101 Bollinger Canyon Road
San Ramon, CA 94583
Tel (925) 790-3946
Fax (925) 790-6772
Cell (925) 487-3584
kjolitz@chevron.com

From: Shuster, Jerry [mailto:Jerry.Shuster@edmondswa.gov]
Sent: Friday, April 19, 2013 10:57 AM
To: Jolitz, Kim S

Cc: Scott.Zorn@arcadis-us.com
Subject: FW: DRAFT: Willow Creek Daylight Early Feasibility Study

Hello,
As a courtesy, the City of Edmonds is providing this opportunity of see the aforementioned draft report. Follow the link below from our consultant. Your comments are welcome.

Also, we are looking for any historical or operational information you may have on the culverts pictured in the attachment. These culverts are on the Unocal property in Willow Creek channel just upstream of where it goes under the tracks (see second attachment)
Was the gate valve installed in case there was a major release from the operating facility? It is being used now? Can we talk about removing them in the future (assuming you still own the property at the time).

Thanks,

Jerry Shuster, P.E.
Stormwater Engineering Program Manager
City of Edmonds
121 5th Ave N.
Edmonds, WA 98020
Desk Phone: 425-771-0220 x1323
Fax: 425-672-5750
Jerry.Shuster@edmondswa.gov

From: Dave Cline [mailto:DRC@shanwil.com]
Sent: Friday, April 12, 2013 1:48 PM
To: Shuster, Jerry; Keeley O'Connell
Cc: Williams, Phil; Hite, Carrie; Paul Schlenger; Kathy Ketteridge; Peter Hummel; Katie Walter
Subject: DRAFT: Willow Creek Daylight Early Feasibility Study

Jerry and Keeley,

The DRAFT Willow Creek Daylight Early Feasibility Study has been posted to the Shannon & Wilson client site, ready for download. You can access the client site using the following instructions:

Willow Creek Daylight
www.shannonwilson.com
Client link in bottom left corner (click)
username: willowcreek
password: daylight
directory: documents

Let me know if you have any trouble downloading the files. Paper copies are in the mail to Jerry.

Have a good weekend.
Dave

SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

David Cline, PE WA | **Senior Associate**
400 N. 34th St., Suite 100
Seattle, WA 98103-8636
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drc@shanwil.com www.shannonwilson.com

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Please consider the environment before printing this e-mail

Dave Cline

From: South, David (ECY) [DSOU461@ECY.WA.GOV]
Sent: Thursday, August 09, 2012 4:16 PM
To: Kim Jolitz (kjolitz@chevron.com)
Cc: Zorn, Scott; Andresen, Rebecca; Greg Glass; Duane Uusitalo; Fordjour, Kojo; Chip Halbert
Subject: Unocal Edmonds - review of sediment results
Attachments: SWA01P0912080712580 (2).pdf; Edmonds Data 8-6-12 (2).pdf

I have reviewed the sediment chemistry results provided by Arcadis in the attached tables, and discussed them with our NWRO sediment specialist. The reported concentrations do not trigger a need for bioassay tests, nor a need for further cleanup in Willow Creek.

Per our telephone conversation last week, the data reviewed have been validated.

The table reviewed was marked draft. If there are any changes to the table, please let me know. In that case, further Ecology review will be necessary.

Please include these results in the next monthly report and the Feasibility Study Report.

David L. South
Senior Engineer
Toxics Cleanup Program, NWRO
3190 160th Avenue SE
Bellevue, WA 98008-5452
425-649-7200

LEGEND:

MW-203 MONITORING WELL LOCATION AND DESIGNATION
MW-122 DEEP MONITORING WELL LOCATION AND DESIGNATION
MW-109 EXISTING SURFACE WATER COMPLIANCE MONITORING WELL LOCATION AND DESIGNATION
MW-518 SURFACE WATER COMPLIANCE MONITORING WELL LOCATION INSTALLED OCTOBER 2008
MW-521 MONITORING WELL LOCATION INSTALLED OCTOBER 2008
P-11 PIEZOMETER
D-1 STAFF GAUGE
2001 AND 2003 SOIL EXCAVATIONS BELOW GROUNDWATER TABLE
LOWER YARD PROPERTY BOUNDARY
—S— STORM DRAIN LINE
2007/2008 EXCAVATION BOUNDARIES
ADDITIONAL GROUNDWATER MONITORING WELLS
MW-528 PROPOSED MONITORING WELLS
SEDIMENT SAMPLE COLLECTION LOCATION THAT FAILED 2003 TOXICITY TESTS
PROPOSED SEDIMENT SAMPLE LOCATION

NOTES:

1. MONITORING WELLS MW-129R, MW-139R, MW-8R, AND MW-149R WERE ABANDONED DURING INTERIM ACTION AND REPLACED IN OCTOBER 2008.
2. STAFF GAUGE D-1 RE-ESTABLISHED PRIOR TO JUNE 2009 SAMPLING EVENT.
3. STAFF GAUGE D-4 WAS ESTABLISHED PRIOR TO JUNE 2009 SAMPLING EVENT TO REPLACE STAFF GAUGE D-7 WHICH IS NOT WITHIN THE WILLOW CREEK CHANNEL.
4. STAFF GAUGES WERE RESURVEYED BY OTAK INCORPORATED JUNE 1, 2009. STAFF GAUGES WERE SURVEYED FROM TOP OF GAUGE AND WATER LEVELS ARE NOW MEASURED FROM TOP DOWN TO WATER.
5. 20-MIL POLYETHYLENE SHEETING INSTALLED UPON COMPLETION OF PHASE I EXCAVATION. SHEETING REACHES TO APPROXIMATELY 10 FT BGS.

DRAFT

CHEVRON ENVIRONMENTAL MANAGEMENT COMPANY
FORMER UNOCAL EDMONDS TERMINAL, LOWER YARD
EDMONDS, WASHINGTON
FEASIBILITY STUDY WORK PLAN

PROPOSED MONITORING MAP

ARCADIS

FIGURE
2

CITY: (TAMPA, FL) SYRACUSE, NY GROUP: ENVCAD DB: (J. RICHARDS), K. DAVIS, P. LISTER PM: R. ANDRESEN TM: S. ZORN TR: D. RASAR LYR: ON=*;OFF=*REF* G:\ENVCAD\SYRACUSE\ACT\B0045362\0003\00017\DWG\FS-WP\45362B10.dwg LAYOUT: 2 SAVED: 7/18/2012 10:49 AM ACADVER: 18.1S (LMS TECH) PAGESETUP: --- PLOTSTYLETABLE: PLTFULL.CTB PLOTTED: 7/18/2012 10:49 AM BY: SCHILLING, ADAM
XREFS: 45362X02 45362X00 45362X03 IMAGES: PROJECTNAME: ---

Table 1 Sediment Data
Former Unocal Edmonds Bulk Fuel Terminal

				Sample ID	US-100		US-101		US-102		DUP-1	
				Lab ID	6738023		6738024		6738025		6738026	
				Sample Date	7/30/2012		7/30/2012		7/30/2012		7/30/2012	
Chemical	**Units**	**SQS[1]**	**CSL[1]**	**LAET[2]**								
Volatile Organic Compounds												
Benzene	mg/kg	NA	NA	NA	0.002	U	0.004	U	0.003	U	0.001	U
Ethylbenzene	mg/kg	NA	NA	NE	0.004	U	0.009	U	0.005	U	0.003	U
Toluene	mg/kg	NA	NA	NA	0.004	U	0.009	U	0.005	U	0.003	U
Xylene (Total)	mg/kg	NA	NA	NE	0.004	U	0.009	U	0.005	U	0.003	U
Petroleum Hydrocarbons												
TPH by NWTPH-Gx soils	mg/kg	NA	NA	NA	45	U	140	U	100	U	41	U
DRO C12-C24 w/Si Gel	mg/kg	NA	NA	NA	7.7	U	29		17		11	
HRO C24-C40 w/Si Gel	mg/kg	NA	NA	NA	26	U	170		110		59	
Metals												
Arsenic	mg/kg	57	93	130	8.53		29.1		20.2		6.87	
Copper	mg/kg	390	390	390	5.7		43.6		21.6		5.05	
Lead	mg/kg	450	530	430	11.2		107		60.6		10	
Zinc	mg/kg	410	960	460	51.5		319		144		41.4	
Conventionals												
TOC	mg/kg	NA	NA	NA	19200		64700		65200		18800	
TOC	%	NA	NA	NA	2		6		7		2	
Moisture	%	NA	NA	NA	60.8		83.6		77.5		60.2	
Ammonia-Nitrogen	mg/kg	NA	NA	NA	148		863		402		163	
PAHs[3]												
Acenaphthene	mg/kg	16	57	0.13	0.27	U	0.012	U	0.0089	U	0.27	U
Acenaphthylene	mg/kg	66	66	0.07	0.57		0.014		0.013		0.34	
Anthracene	mg/kg	220	1200	0.28	0.45		0.034		0.023		0.39	
Benzo(a)anthracene	mg/kg	110	270	0.96	0.63		0.16		0.061		0.64	
Benzo(a)pyrene	mg/kg	99	210	1.10	0.68		0.22		0.084		0.69	
Benzo(b)fluoranthene	mg/kg	NA	NA	NA	1.15		0.42		0.15		1.22	
Benzo(g,h,i)perylene	mg/kg	31	78	0.67	0.89		0.19		0.067		0.69	
Benzo(k)fluoranthene	mg/kg	NA	NA	NA	0.36		0.14		0.06		0.44	
Chrysene	mg/kg	110	460	0.95	0.94		0.28		0.11		1.01	
Dibenz(a,h)anthracene	mg/kg	12	33	0.23	0.27	U	0.042		0.015		0.27	U
Fluoranthene	mg/kg	160	1200	1.30	2.40		0.46		0.21		2.29	
Fluorene	mg/kg	23	79	0.12	0.45		0.059		0.028		0.53	
Indeno(1,2,3-cd)pyrene	mg/kg	34	88	0.60	0.68		0.17		0.057		0.53	
Naphthalene	mg/kg	99	170	0.23	2.92		0.052		0.059		1.38	
Phenanthrene	mg/kg	100	480	0.66	2.29		0.18		0.11		1.91	
Pyrene	mg/kg	1000	1400	2.40	2.34		0.44		0.19		2.18	
Total LPAH[4]	mg/kg	370	780	1200	6.68		0.34		0.23		4.55	
Total HPAH[5]	mg/kg	960	5300	7900	10.05		2.52		1.00		9.69	

Notes:
PAH = Polycyclic aromatic hydrocarbons
LPAH = low molecular weight PAH
HPAH = high molecular weight PAH
SQS = Sediment Quality Standards
CSL = Cleanup Screening Levels
NA = Not applicable
NE= Not evaluated because these analytes do not have SQS or CSL.
U = Indicates the value was below the Method Detection Limit.

1. SQS and CSL from Chapter 173-204 WAC Sediment Management Standards. PAH results for US-100 and DUP-1 are organic carbon normalized.

2. LAET from Puget Sound Dredged Disposal Analysis. 1996. Progress Re-evaluation Puget Sound Apparent Effects Thresholds (AETs). LAET value is the lowest concentration of the echinoderm, microtox, and oyster AETs from Table 9.
3. Samples US-100 and DUP-1 required normalization as TOC fell in the range of 0.2 to 4%. PAH values were normalized by dividing the original concentration by the TOC percentage expressed as a decimal.
4. Total LPAH is the sum of naphthalene, acenaphthylene, acenaphthene, fluorene, phenanthrene, and anthracene. Non-detect values are treated as zero in the summation.

Table 1 Sediment Data
Former Unocal Edmonds Bulk Fuel Terminal

5. Total HPAH is the sum of fluoranthene, pyrene, benz(a)anthracene, chrysene, total benzofluoranthenes, benzo(a)pyrene, indeno(1,2,3,-c,d)pyrene, dibenzo(a,h)anthracene, and benzo(g,h,i)perylene. Non-detect values are treated as zero in the

6. US-100 and DUP-1 were compared to SQS and CSL screening criteria and US-101 and US-102 were compared to LAET based on TOC concentrations and Ecology guidance (Washington Department of Ecology. 1992 and 1993. Organic Carbon Normalization of Sediment Data)

7. All results are reported on a dry weight basis except as indicated in footnote 3.

APPENDIX D

IMPORTANT INFORMATION ABOUT YOUR ENVIRONMENTAL SITE ASSESSMENT/EVALUATION REPORT

IMPORTANT INFORMATION ABOUT YOUR GEOTECHNICAL/ENVIRONMENTAL REPORT

CONSULTING SERVICES ARE PERFORMED FOR SPECIFIC PURPOSES AND FOR SPECIFIC CLIENTS.

Consultants prepare reports to meet the specific needs of specific individuals. A report prepared for a civil engineer may not be adequate for a construction contractor or even another civil engineer. Unless indicated otherwise, your consultant prepared your report expressly for you and expressly for the purposes you indicated. No one other than you should apply this report for its intended purpose without first conferring with the consultant. No party should apply this report for any purpose other than that originally contemplated without first conferring with the consultant.

THE CONSULTANT'S REPORT IS BASED ON PROJECT-SPECIFIC FACTORS.

A geotechnical/environmental report is based on a subsurface exploration plan designed to consider a unique set of project-specific factors. Depending on the project, these may include: the general nature of the structure and property involved; its size and configuration; its historical use and practice; the location of the structure on the site and its orientation; other improvements such as access roads, parking lots, and underground utilities; and the additional risk created by scope-of-service limitations imposed by the client. To help avoid costly problems, ask the consultant to evaluate how any factors that change subsequent to the date of the report may affect the recommendations. Unless your consultant indicates otherwise, your report should not be used: (1) when the nature of the proposed project is changed (for example, if an office building will be erected instead of a parking garage, or if a refrigerated warehouse will be built instead of an unrefrigerated one, or chemicals are discovered on or near the site); (2) when the size, elevation, or configuration of the proposed project is altered; (3) when the location or orientation of the proposed project is modified; (4) when there is a change of ownership; or (5) for application to an adjacent site. Consultants cannot accept responsibility for problems that may occur if they are not consulted after factors which were considered in the development of the report have changed.

SUBSURFACE CONDITIONS CAN CHANGE.

Subsurface conditions may be affected as a result of natural processes or human activity. Because a geotechnical/environmental report is based on conditions that existed at the time of subsurface exploration, construction decisions should not be based on a report whose adequacy may have been affected by time. Ask the consultant to advise if additional tests are desirable before construction starts; for example, groundwater conditions commonly vary seasonally.

Construction operations at or adjacent to the site and natural events such as floods, earthquakes, or groundwater fluctuations may also affect subsurface conditions and, thus, the continuing adequacy of a geotechnical/environmental report. The consultant should be kept apprised of any such events, and should be consulted to determine if additional tests are necessary.

MOST RECOMMENDATIONS ARE PROFESSIONAL JUDGMENTS.

Site exploration and testing identifies actual surface and subsurface conditions only at those points where samples are taken. The data were extrapolated by your consultant, who then applied judgment to render an opinion about overall subsurface conditions. The actual interface between materials may be far more gradual or abrupt than your report indicates. Actual conditions in areas not sampled may differ from those predicted in your report. While nothing can be done to prevent such situations, you and your consultant can work together to help reduce their impacts. Retaining your consultant to observe subsurface construction operations can be particularly beneficial in this respect.

A REPORT'S CONCLUSIONS ARE PRELIMINARY.

The conclusions contained in your consultant's report are preliminary because they must be based on the assumption that conditions revealed through selective exploratory sampling are indicative of actual conditions throughout a site. Actual subsurface conditions can be discerned only during earthwork; therefore, you should retain your consultant to observe actual conditions and to provide conclusions. Only the consultant who prepared the report is fully familiar with the background information needed to determine whether or not the report's recommendations based on those conclusions are valid and whether or not the contractor is abiding by applicable recommendations. The consultant who developed your report cannot assume responsibility or liability for the adequacy of the report's recommendations if another party is retained to observe construction.

THE CONSULTANT'S REPORT IS SUBJECT TO MISINTERPRETATION.

Costly problems can occur when other design professionals develop their plans based on misinterpretation of a geotechnical/environmental report. To help avoid these problems, the consultant should be retained to work with other project design professionals to explain relevant geotechnical, geological, hydrogeological, and environmental findings, and to review the adequacy of their plans and specifications relative to these issues.

BORING LOGS AND/OR MONITORING WELL DATA SHOULD NOT BE SEPARATED FROM THE REPORT.

Final boring logs developed by the consultant are based upon interpretation of field logs (assembled by site personnel), field test results, and laboratory and/or office evaluation of field samples and data. Only final boring logs and data are customarily included in geotechnical/environmental reports. These final logs should not, under any circumstances, be redrawn for inclusion in architectural or other design drawings, because drafters may commit errors or omissions in the transfer process.

To reduce the likelihood of boring log or monitoring well misinterpretation, contractors should be given ready access to the complete geotechnical engineering/environmental report prepared or authorized for their use. If access is provided only to the report prepared for you, you should advise contractors of the report's limitations, assuming that a contractor was not one of the specific persons for whom the report was prepared, and that developing construction cost estimates was not one of the specific purposes for which it was prepared. While a contractor may gain important knowledge from a report prepared for another party, the contractor should discuss the report with your consultant and perform the additional or alternative work believed necessary to obtain the data specifically appropriate for construction cost estimating purposes. Some clients hold the mistaken impression that simply disclaiming responsibility for the accuracy of subsurface information always insulates them from attendant liability. Providing the best available information to contractors helps prevent costly construction problems and the adversarial attitudes that aggravate them to a disproportionate scale.

READ RESPONSIBILITY CLAUSES CLOSELY.

Because geotechnical/environmental engineering is based extensively on judgment and opinion, it is far less exact than other design disciplines. This situation has resulted in wholly unwarranted claims being lodged against consultants. To help prevent this problem, consultants have developed a number of clauses for use in their contracts, reports and other documents. These responsibility clauses are not exculpatory clauses designed to transfer the consultant's liabilities to other parties; rather, they are definitive clauses that identify where the consultant's responsibilities begin and end. Their use helps all parties involved recognize their individual responsibilities and take appropriate action. Some of these definitive clauses are likely to appear in your report, and you are encouraged to read them closely. Your consultant will be pleased to give full and frank answers to your questions.

The preceding paragraphs are based on information provided by the
ASFE/Association of Engineering Firms Practicing in the Geosciences, Silver Spring, Maryland