Three Meadows Restoration

Existing Conditions Assessment and Restoration Alternatives - DRAFT

prepared for

Amanda Watson, Amador Resource Conservation District

prepared by

John Dvorsky

Principal Scientist

WATERWAYS CONSULTING, INC.

January 14, 2019

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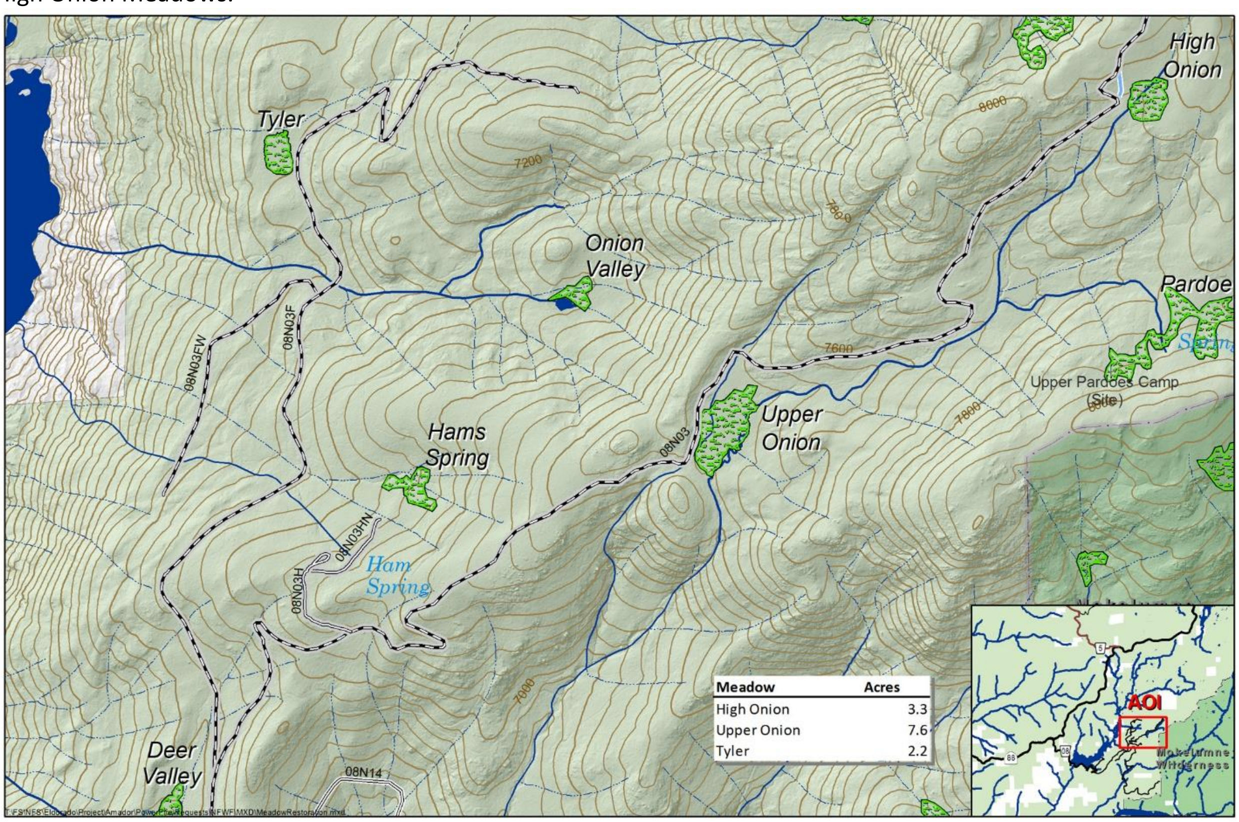
1.0 INTRODUCTION

1.1 Project Overview

Many meadows throughout the Sierra Nevada have been degraded from historic land use practices, resulting in channel incision that has impacted natural ecological and hydrological functions. Within the Mokelumne River watershed, a diverse group of stakeholders formed the Amador Calaveras Consensus Group (ACCG) to address these impacts and have collaborated to solicit funding in support of efforts to restore these unique meadow habitats. To increase the pace and scale of meadow restoration in the Mokelumne watershed, ACCG members and the Amador Resource Conservation District (ARCD) received funding to conduct an assessment and develop preliminary restoration plans for Upper Onion, High Onion, and Tyler Meadows, referred to as the "Three Meadows" project area (Figure 1). Efforts to restore these meadows is being conducted in parallel with a similar effort at Indian Valley, Foster Meadow, and Little Indian Valley by the U.S. Forest Service's (USFS) Amador Ranger District. This report has been prepared to summarize the results of the existing conditions assessment and identify the range of potential restoration actions at the site for review and selection by the stakeholder committee.

Figure 1: Overview of the project area. The Three Meadows Restoration area includes Tyler, Upper Onion, and High Onion Meadows.



1.2 Restoration Objectives

Sierran wet meadow complexes provide important ecological benefits but are an increasingly threatened habitat type. Despite the fact that they only represent a small percentage of the overall landscape, they play an outsized role in supporting floral and faunal diversity in the landscape. Although often degraded from altered hydrology, channel incision, and encroachment of the adjacent coniferous forest, wet meadows provide critical habitat for the Sierra Nevada Yellow-legged Frog (SNYLF), *Rana sierra*, and support sensitive plant species such as rare moonworts, *Botrychium sp*. Absent a plan for restoration, these meadows are at risk of losing important ecological and hydrological functions. In addition to their value to threatened and endangered plants and animals, meadows provide other beneficial uses including forage for commercial grazing activities and native ungulates, recreation, and water storage for power generation and domestic water supply downstream.

Given their threatened status and the importance of these habitat types in the larger forest ecosystem, a long-term set of objectives to restore meadow function would include:

- Restore the natural hydrology of the meadow to raise the groundwater elevation and increase natural water storage,
- Restore the natural morphology of the meadow to recover sediment deposition function,
- Arrest channel headcutting,
- Increase and prolong the duration of late-season flows for the benefit of flora and fauna and downstream water users,
- Reduce downstream flood peaks,
- Halt the encroachment of upland plant species, particularly lodgepole pine,
- Increase extent and quality of wet meadow and riparian vegetation, and
- Improve habitat for meadow species, with focus on sensitive plant species and the Sierra Nevada Yellow-legged Frog (SNYLF).

Specific restoration actions designed to achieve these restoration objectives would likely be different at each of the meadows included in the Three Meadows project area. The specific actions are identified based on the assessed conditions and impacts.

2.0 EXISTING CONDITIONS

2.1 Site Setting

The project area encompasses three relatively small, high elevation meadows in Amador County, California. The three meadows include Upper Onion, High Onion, and Tyler and are located approximately 50 miles northeast of Jackson, CA, and east of Bear River Reservoir in the Amador Ranger District of the Eldorado National Forest (Figure 1). Tyler meadow is in the Bear River watershed and High Onion and Upper Onion are in the Cole Creek watershed. High Onion Meadow (~ 3 acres @ 8,000 feet elevation) and Upper Onion Valley Meadow (~7 acres @ 7,480 feet) are located on Onion Creek, which ultimately flows into Cole Creek and the North Fork Mokelumne River, about 1.7 miles downstream from Salt Springs Reservoir. Tyler Meadow (~2 acres @ 6,800 feet) drains into Upper Bear River Reservoir which feeds Bear River and Bear River Reservoir. Upper Onion has a drainage area of approximately 0.7 square miles (450 acres) consisting of two principal tributaries with drainage areas of 0.6 square miles and 0.1 square mile. Both High Onion and Tyler have a drainage area of approximately 0.1 square mile (64 acres).

2.2 Geomorphology

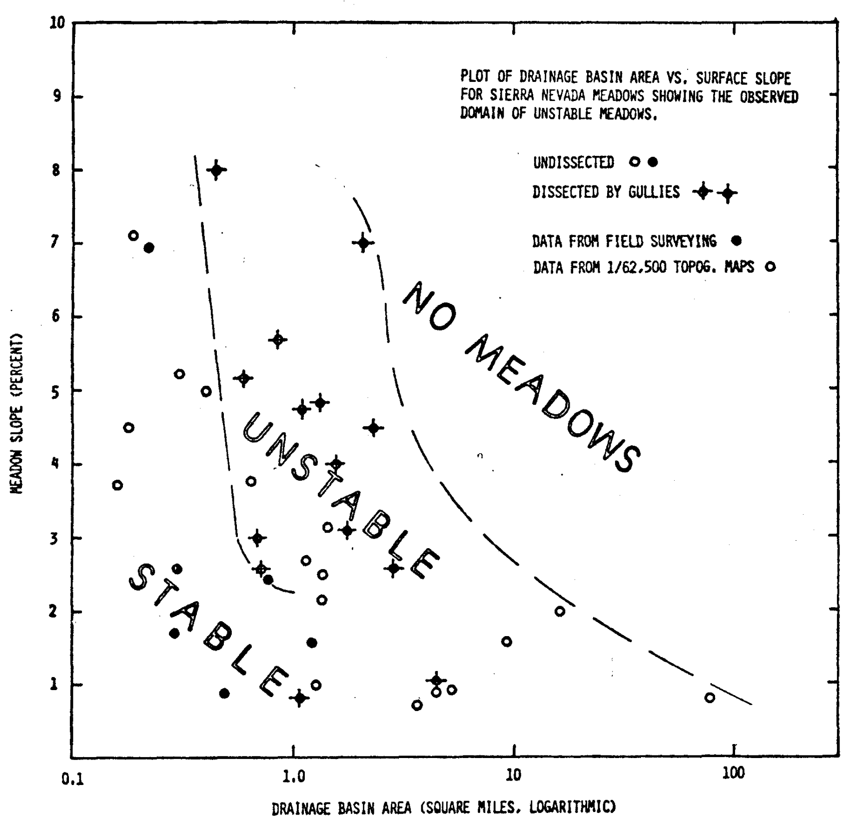
Meadows exist as small pockets of grassland in a landscape largely dominated by forest where downstream controls, such as a bedrock outcrop or terminal moraine, create a flatter longitudinal profile that encourages sediment deposition. According to Wood (1975) meadows are characterized by two fundamental physical conditions: 1) A shallow water table that rarely exceeds two feet in depth at mid-summer, and 2) Surficial material that is fine textured and richly organic. Similarly, according to Wood (1975), whether a meadow occurs at a particular location in the landscape is a function of the size of the drainage basin feeding the meadow and the overall meadow slope. The drainage basin needs to be large enough to provide adequate flow and seepage water from the hillslopes to maintain a high water table during the growing season but not too large where high flows mobilize the fine-grained material. Valley slope has a similar influence on whether or not a meadow will be present. If the slope is too steep, sediment will be mobilized, resulting in channel incision that lowers the groundwater table to the point where the forest encroaches.

Wood (1975) also discusses some general rules of thumb about meadow morphology, expected occurrence of channels in a meadow, and generally how resilient meadows are to disturbance. He reached the following conclusions:

- Meadows typically occur where the ratio between drainage area and meadow area is between 5 and 25. For the Three Meadows, Tyler has a ratio of 32, High Onion has a ratio of 21, and Upper Onion has a ratio of 64.

- A more important metric determining meadow stability is the relationship between drainage area and valley slope. Wood (1975) plotted these relationships for numerous meadows throughout the Sierra Nevada and characterized stable and unstable meadow regimes (Figure 2). Tyler and High Onion both fell solidly in the "stable" regime whereas Upper Onion falls near the break between "stable" and "unstable".
- Wood developed a general rule of thumb that states that meadows with drainage basins smaller than 0.8 square miles and valley slopes less than 2% do not commonly have a through flowing stream channel. Tyler meadow falls solidly within this description. Upper Onion, with a drainage area of 0.7 square miles and a valley slope of approximately 1.7% is on the upper end of this range. High Onion significantly exceeds the valley slope requirement and is expected to have a flow through channel.

Figure 2: Meadow stability in the Sierra Nevada Mountains as a function of meadow slope and drainage basin area according to Wood (1975).



This last point is highly relevant to this project, especially Upper Onion and Tyler. The topography and specific features of these meadows suggest that these meadows formed in a depositional environment with limited channel formation. Flow entering the meadow at the upstream end spread out into shallow, overland flow and interacted with a rough meadow surface consisting of grasses and shrubs.

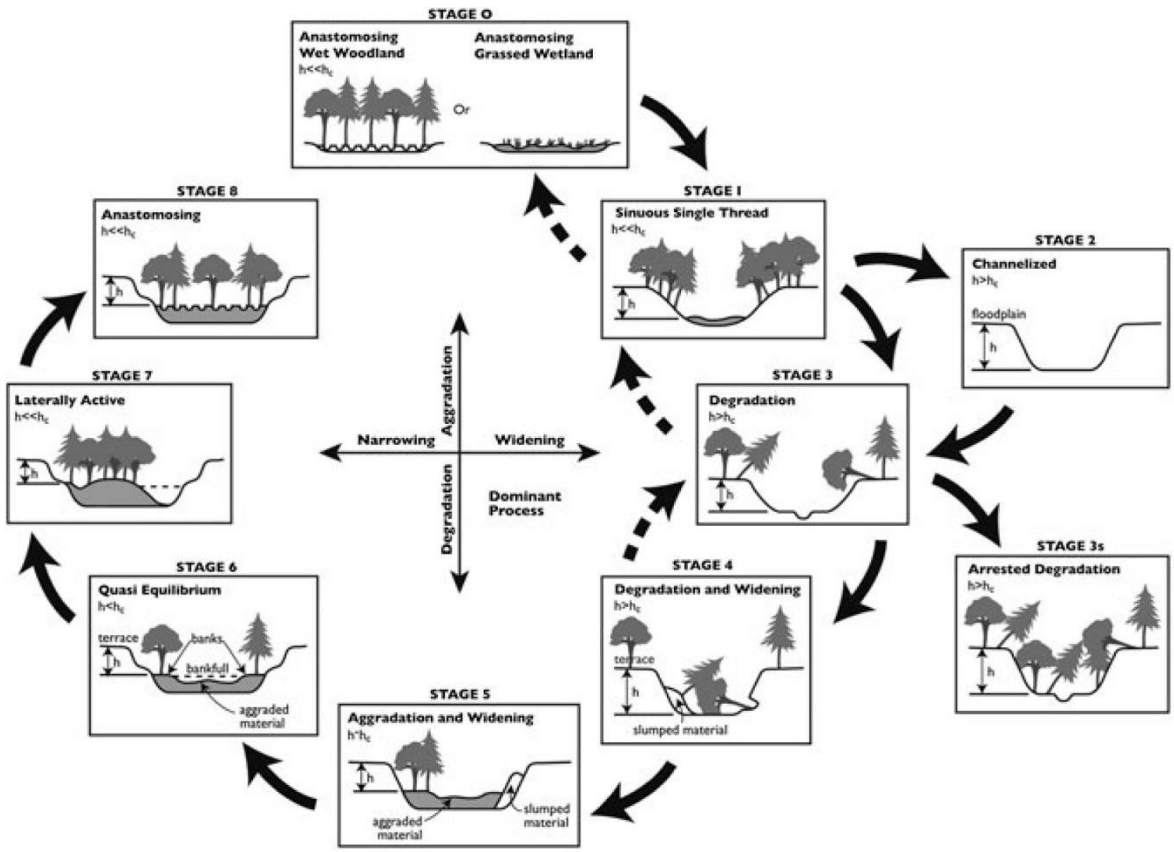
Low areas in the meadow, furthest away from the alluvial fan, would have ponded and the meadow would have aggraded over time from a combination of delivered sediments and organic matter. This would have produced a profile characterized by a flatter slope at the upper end of the meadow on the alluvial fan, a slightly steeper slope in the middle of the meadow representing the base of the fan, and a lower slope at the downstream end of the meadow due to the presence of the bedrock outcrop or terminal moraine. This is the exact scenario observed at Upper Onion.

Various types of disturbances could impact this delicate balance and shift the landform from depositional to erosional. Those disturbances include livestock grazing, which reduces the overall roughness of the meadow surface and increases overland flow velocities, or an increase in flow to the meadow from the watershed that may be a result of more efficient drainage networks (e.g. – roads, channelization, etc.) or logging. Similarly, a variety of disturbances downstream of the meadow could result in headward migration of a knickpoint that could cause incision of a channel through the meadow, independent of land uses within the meadow or upstream watershed. These impacts ultimately lead to formation of a more defined channel, or set of channels, through the meadow which potentially lowers the water table to the point where at least one of the two primary criterion than define a meadow, according to Wood (1975), are no longer being met.

Following an initial disturbance, positive feedback loops are often established that lead to additional channel incision and loss of meadow function. This process is not unique to meadows and has been characterized by a number of researchers (Schumm et al, 1984; Simon and Hupp, 1986) and referred to as the Channel Evolution Model. This model identifies a series of stages that channels typically go through following a disturbance. The initial disturbance results in incision, followed by widening as the incision destabilizes streamside vegetation, followed by aggradation as the channel becomes overwhelmed by the material contributed locally from the banks, followed by a new state of equilibrium as a new inset floodplain is established and the former floodplain surface becomes terrace. Depending on the site opportunities and constraints, restoration efforts on incised channels either seek to turn back the clock and restore the channel by aggrading it to improve interaction with the historic floodplain, or push the process forward to the new equilibrium by excavating terrace material to create an inset floodplain.

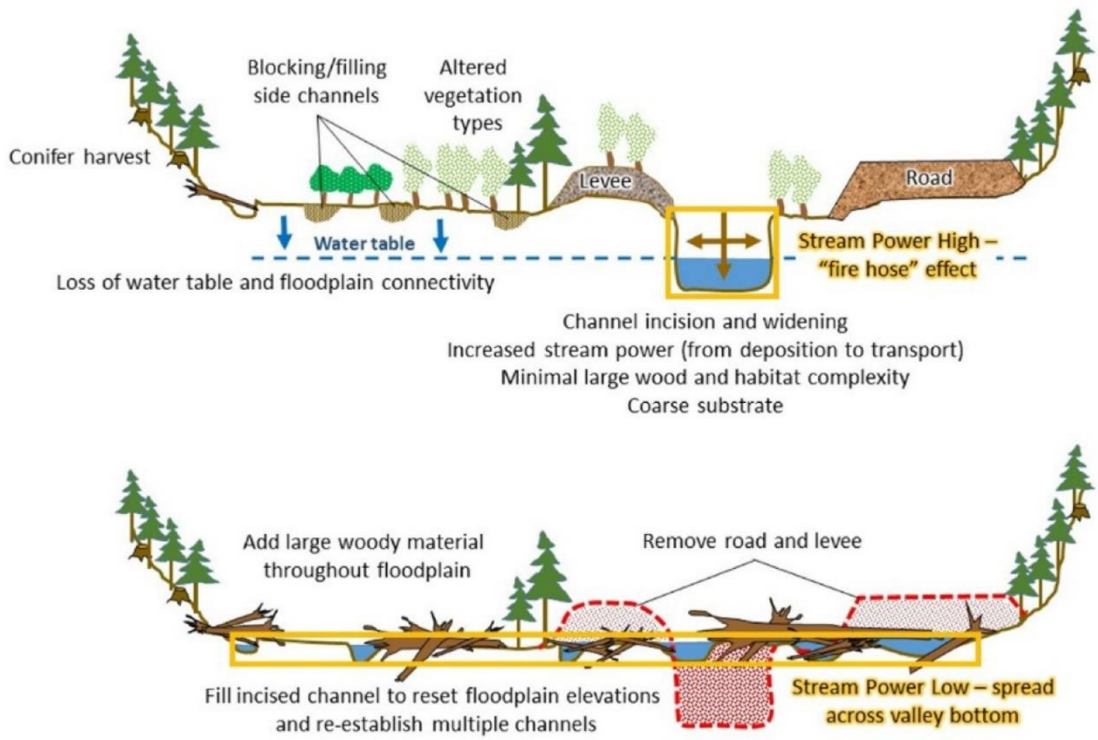
Recent research, culminating in a paper by Cluer and Thorne (2014) sought to address limitations in the Channel Evolution Model in depositional environments where single-thread channels were not likely to be present historically but instead the channel network is either anastomosing or not present at all. They expanded the Channel Evolution Model to include the “Stage 0” morphology and suggested that these landforms require a completely different approach to restoration. Figure 3 presents a graphic from Cluer and Thorne that show how the Stage 0 concept fits in with the Channel Evolution Model and what restoration approaches might look like.

Figure 3: Reimagined Channel Evolution Model that includes depositional environments dominated by anastomosing channels, referred to as Stage 0 (from Cluer and Thorne 2014).



Since the publication of this paper, restoration practitioners have been experimenting with the Stage 0 concept in both meadow and forested settings in the Pacific Northwest. These efforts initially began in smaller meadow systems but have been expanded to larger sites including a recent project that implemented the approach on a large mainstem tributary of the Willamette River (Staley Creek, Middle Fork Willamette River; https://www.middleforkwillamette.org/restore/rivers-and-streams/staley-creek/). The U.S. Forest Service (USFS) has been at the forefront of these efforts given the fact that they are a single contiguous landowner and may have a more streamlined regulatory environment to navigate. They have also developed several useful GIS tools to evaluate opportunities for Stage 0 restoration on the landscape. Their conceptual model is illustrated in Figure 4, which was borrowed from a technical newsletter produced by USFS' National Stream and Aquatic Ecology Center. It provides a more detailed look at the geomorphic, hydraulic, ecological, and groundwater benefits of a restoration approach that focuses specifically on historically depositional reaches.

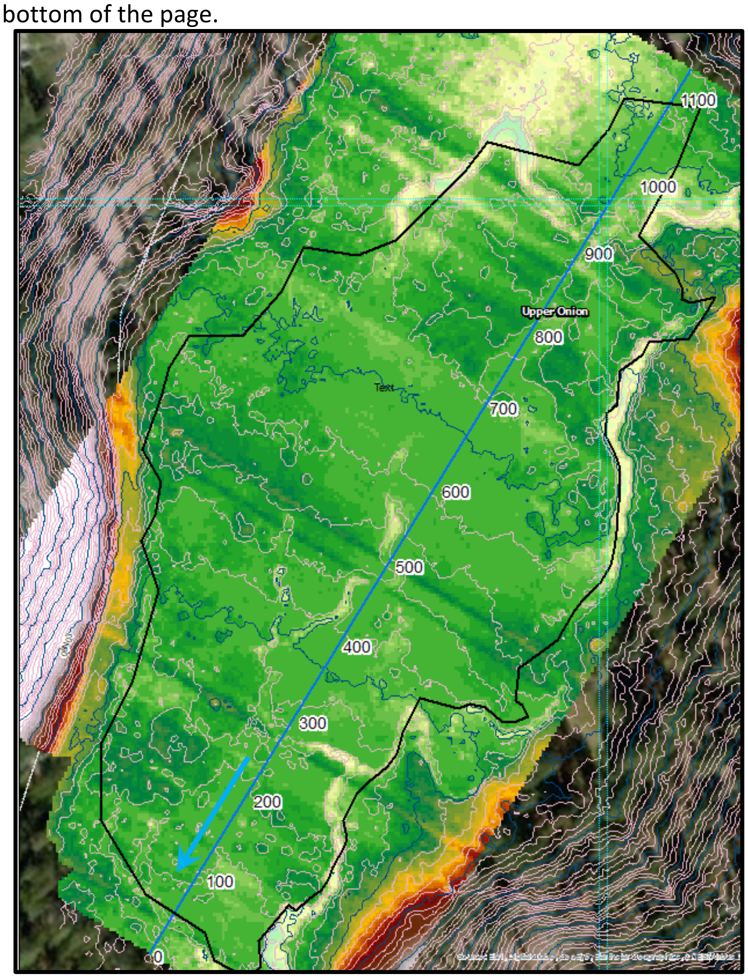
Figure 4: Conceptual cross-section of before and after condition of a Stage 0 restoration project (from a technical newsletter produced by USFS' National Stream and Aquatic Ecology Center).



One of those tools uses LiDAR data for a site to generate a Relative Elevation Map (REM) of the project area. This is done by utilizing a user-defined profile of the meadow, which is drawn down the slope of the meadow from the upstream end to the outlet. This profile is then used to compare the elevation of the meadow at the profile to adjacent elevations along a series of perpendicular cross-sections. The result is a map of elevational difference between the historic meadow surface and adjacent ground with negative representing areas of incision and positive values representing areas of deposition. The map produced for Upper Onion provides a clear representation of where incision is most severe (Figure 5). It also provides a tool for evaluating where fill is necessary to return a project site to a Stage 0 condition and where there are opportunities to borrow material to fill the incised areas.

The REM was only generated for Upper Onion Meadow because it was determined to be an historically depositional environment and has experienced cumulative impacts that have caused it to cross a threshold from depositional to erosional. Determining the specific forcers and a timeline of events that led to the initial perturbation and degradation is difficult, if not impossible. It is likely a combination of factors such as heavy, prolonged grazing, followed by modifications to the hydrology. As mentioned previously, slight changes in the independent physical variables can lead to significant changes in meadow condition. For example, there is evidence that the Upper Onion site has not always been a meadow. During the site visit we observed stumps that had been exhumed due to channel incision. This observation mirrors what was documented by Wood (1975) in incised meadows channels throughout the Sierra Nevada. Wood conducted detailed stratigraphic analysis of these meadows using carbon dating and other methods and came to the conclusion that many of these meadows were forested up until approximately 1,200 year before present (ybp). Climatic variation, initiated by a neoglacial event from approximately 2800 ybp and 1200 ybp, led to loss of forest cover and a rise in the water table in depositional basins. Continued late season snow pack has maintained these conditions to the present date. This has implications for climate change associated with the rise of atmospheric CO^2.

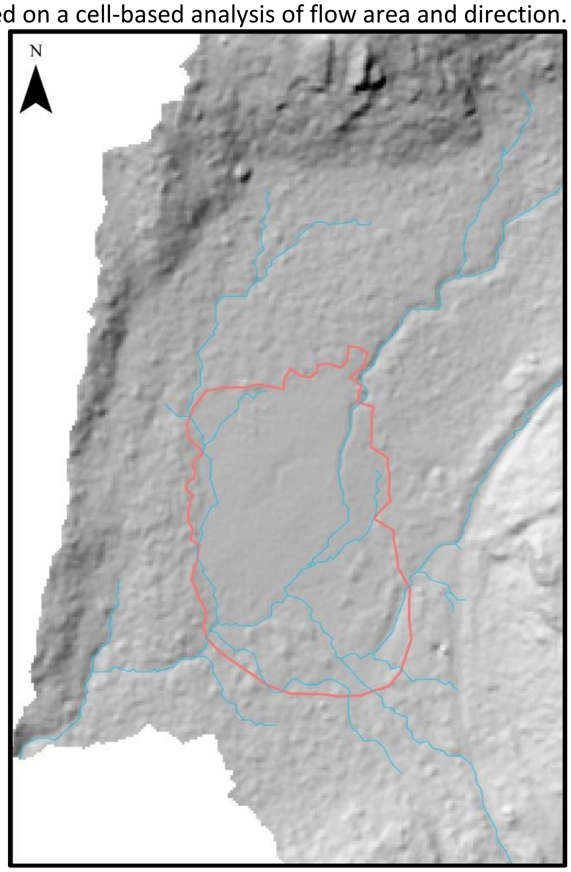
Figure 5: Relative elevation map of Upper Onion Valley based on a user-defined geomorphic profile of the meadow (blue line). Light green represents areas where the elevation equals the profile. Dark green represents areas higher than the profile. Yellow and blue represents areas that presumably have incised. The downstream outlet of the meadow is at the bottom of the page.



Much of the discussion above has been focused on conditions at Upper Onion Meadow. Although the same physical variables apply, conditions on Tyler and High Onion Meadows are different then what is occurring at Upper Onion for a variety of reasons. At Tyler, impacts to the meadow and surrounding watershed has not led to incision of the meadow. There are signs that grazing impacts have significantly impacted the ecological value of the meadow and access to the meadow from OHV's have caused localize impacts, but in general it does not appear there have been water table impacts that directly relate to channel incision.

The primary issue at Tyler is the condition of the channel upstream of the meadow, whether or not that area was historically part of the meadow, and what the benefits would be of attempting to aggrade the channel. The apparent age of the trees upstream of Tyler Meadow suggests that it has been forested for quite some time. The drainage area at the outlet of Tyler was calculated to be 0.1 square mile. A closer look at the topography of the watershed that drains to Tyler suggests that the actual drainage contribution to the upper end of the meadow may be less than half of that (Figure 6). Two other drainages enter the meadow downstream of the primary drainage, which may have a significant influence on groundwater depths longitudinally along the meadow and up into the forested portion of the Tyler drainage.

Figure 6: Shaded relief map of Tyler Meadow using LiDAR data. The blue lines represent LiDAR derived stream channels based on a cell-based analysis of flow area and direction.



Depth to bedrock, which controls the outlet of the meadow, is also unknown along the profile. The bedrock surface may be somewhat uniform and flat, whereas the ground surface is sloped, producing a shallower depth to bedrock at the downstream end of the basin with greater depths in the upstream direction. The survey data shows a meadow slope of approximately 1.2% and a valley slope of 1.8% in the forested reach. The result would be a shallower water table at the downstream end of the basin which may result in meadow conditions in a portion of the basin and forested conditions upstream. The presence of a channel in the forested reach and an absence of channels in the meadow reach could primarily be a function of differences in channel slope, impacts on surface conditions from cattle, and the impact of a more efficient drainage network and higher peak flows due to the presence of the road.

A landscape analysis of High Onion Meadow suggests that it is a much different meadow, morphologically, than Upper Onion and Tyler (Figure 7). The high groundwater table appears to be driven by subsurface flow from colluvial material from adjacent hillslopes and alluvial fans that intersect at this location in the landscape, forcing water to the surface. Upper Onion appears to be one piece of a mosaic of "forest-free" areas in this headwater region of the Onion Creek drainage (Figure 8). It is one of the larger tree free areas and is bisected by the primary channel of Onion Creek, which has incised into the intersecting depositional areas. The overall slope of the meadow exceeds 5% though the stepped nature of the intersecting fans results in some portions of the meadow being flatter than 5% and some portions being much steeper. Slight incision of the primary channel appears to be the result of grazing and increased peak flow associated with the adjacent road network.

Figure 7: Color ramp elevation map of High Onion and adjacent areas from LiDAR. Each color band represents approximately a 3 foot band.

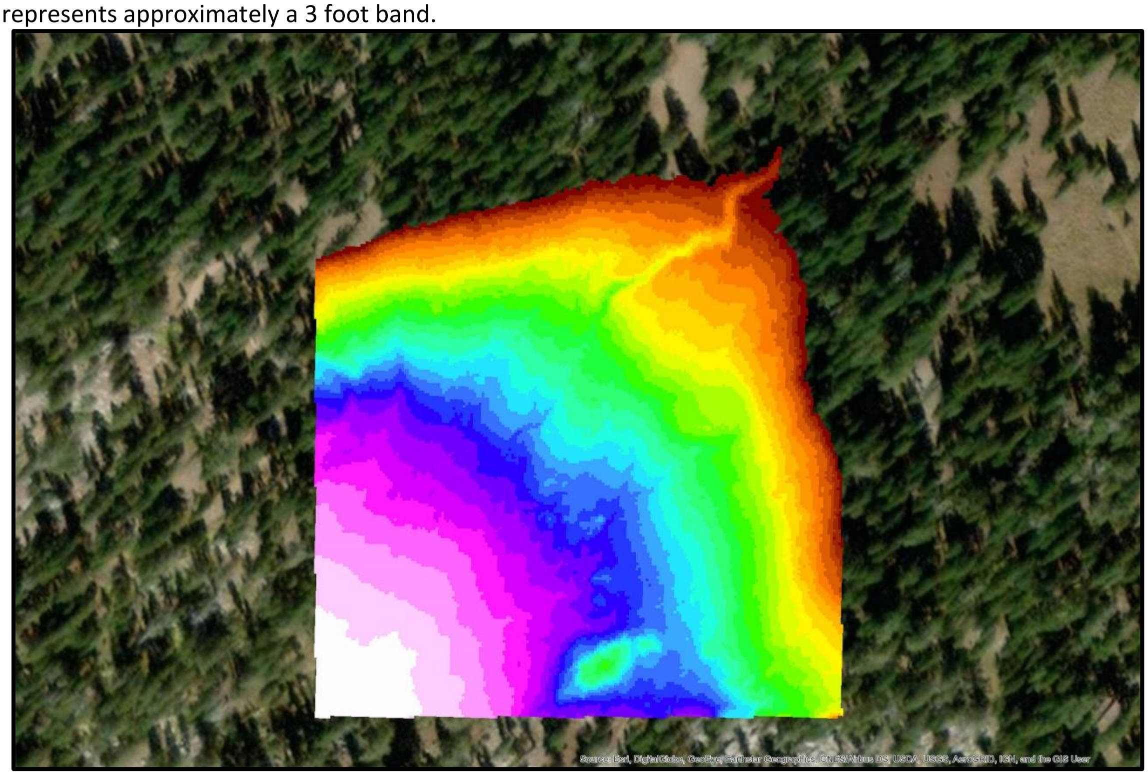


Figure 8: Aerial photo view of High Onion Meadow and surrounding area. The open meadow condition at High Onion is not unusual in this headwater region where seepage water from adjacent hillslopes and convergence of drainage networks result in locally high groundwater.

2.3 Hydrology

Given the elevation of the three meadows, the hydrology is dominated by the melting of winter snowpack. Peak events typically occur in late spring or early summer and often occur when nighttime temperatures stay above freezing for several days in a row. The magnitude of the peak event in any given year is often dictated by the depth of the winter snowpack though extreme high temperatures in conditions of lower snowpack depths can result in large peak flow events. High flows can also occur when significant snowfall and a deep snowpack is followed by a prolonged rain-on-snow event, often referred to as a “Pineapple Express” or atmospheric river because subtropical moisture is entrained into a jet stream that is locked into a particular configuration. These events are rare, on the order of every 10 years, but result in the largest magnitude discharge events on record and typically occur in January or February. Wood (1975) suggests that these events are the primary drivers of both erosional and depositional features in these meadow systems.

Peak flow estimates for a range of return periods were developed for each of the meadows using the StreamStats tool developed by USGS. This tool was used because the drainages themselves are not gaged by USGS, therefore no streamflow data are available, and similarly-sized drainages in the region are not gaged. There is a gaging site located on Cole Creek near the Salt Springs Reservoir but the drainage area of this gage is 21 square miles, significantly larger than any of the meadows within the Three Meadows project area. The USGS also maintains several gages on smaller tributaries in the Kirkwood region but the smallest drainage area is 7.3 square miles and the gage is located downstream of a regulated reservoir and doesn't represent natural hydrologic conditions. A summary of the Streamstats results for each of the meadows is presented in Table 1. The results for Upper Onion has been divided into two summaries for the primary drainage entering Upper Onion at the fan surface (drainage area of 0.6 square miles) and the drainage that crosses the access road to the camping area (drainage area of 0.1 square miles).

TABLE 1: PEAK DISCHARGE ESTIMATES BASED ON REGIONAL REGRESSION EQUATIONS

Return Period (years)	Peak Flow Estimates for Upper Onion Main Tributary (cfs)	Peak Flow Estimates for Upper Onion Road Tributary (cfs)	Peak Flow Estimates for High Onion (cfs)	Peak Flow Estimates for Tyler (cfs)
2	18.4	3.5	3.6	3.7
5	43	8.5	8.5	8.7
10	68	14	14	14
25	111	23	23	23
50	154	32	32	32
100	206	43	44	43

3.0 RESTORATION ACTIONS

3.1 Overview

Given the significant differences in the physical characteristics of each of the meadows within the Three Meadows project area, the degree to which land use impacts have degraded their condition, and their overall ecological value, a different set of restoration actions or alternatives needs to be considered for each meadow. Where channel incision has been observed, the objective would be to reverse the process of degradation and encourage sediment deposition, though the approach may vary at each meadow, or in specific areas of each meadow, based on the degree of incision. By implementing measures that will reduce incision and encourage deposition, it is postulated that the water table will rise and restore more natural functions of wet meadow habitat. In the case of Upper Onion, restoration of natural meadow conditions is expected to increase the distribution of native plant species such as the rare moonworts (*Botrychium sp.)* and increase the extent and duration of ponded water in low areas to support native animals such as Sierra Nevada Yellow-legged Frog (SNYLF), *Rana sierra*. Restoring the natural hydrology and historic buffering function of a wet meadow system is also expected to enhance storage and slow the release of water for a variety of downstream benefits.

Although restoration actions are being proposed for all three of the meadows, more effort is paid to Upper Onion meadow because it is significantly larger than the other two meadows, currently supports the species identified above, and is the most degraded. Opportunities for restoration at Upper Onion Meadow include the following:

- The site is easily accessible by a well-developed road that runs along the entire north side of the meadow,
- A potentially staging area already exists at the site within the seasonal primitive camping area,
- Large trees within and adjacent to the meadow may be available for use in the project,
- The site is located entirely on public land within USFS property,
- Borrow material, consisting of fine-grained material, is present in areas adjacent to the meadow if needed,
- The meadow currently provides habitat for the two, target species identified above, providing a template on the preferred habitat type that could be replicated through the proposed restoration actions,
- Previous USFS restoration efforts at the meadow resulted in some success at utilizing log weirs to aggrade portions of the incised channels, which could be used as a template for elsewhere in the meadow, and
- Late summer is characterized by little to no flow in the meadow which provides ideal conditions for construction.

Despite these opportunities for restoration, constraints to fully achieve the stated goals for a selected restoration action also need to be considered. The constraints for Upper Onion include the following:

- Despite the recent efforts to address erosion sources and hydrologic impacts of the adjacent road network, the continued use of the access road will provide a long-term source of increased sediment supply and discharge to the meadow,
- The presence of the target species may limit the proposed restoration activities in areas where individuals of those species currently occur or have been identified,
- The meadow is contained within an active grazing allotment and will continue to experience impacts associated with grazing,
- The site is remote so any materials that need to be imported will require long-distance travel, which can raise costs,
- The primitive camping area and associated access road will continue to be an impact to the site, and
- Climate change impacts on snowpack and the timing of snowmelt may continue to have detrimental impacts on the long-term viability of the meadow that will not be addressed through any proposed restoration actions.

Restoration opportunities for High Onion Meadow include the following:

- The site is accessible from a well-developed forest road,
- Trees within and adjacent to the meadow may be available for use in the project,
- The site is located entirely on public land within USFS property,
- Only limited recreational use appears to occur within the meadow, and
- Late summer is characterized by little to no flow in the meadow which provides ideal conditions for construction.

Despite these opportunities for restoration, constraints to fully achieve the stated goals for a selected restoration action also need to be considered. The constraints for High Onion include the following:

- Despite the recent efforts to address erosion sources and hydrologic impacts of the adjacent road network, the continued use of the access road will provide a long-term source of increased sediment supply and discharge to the meadow,
- The meadow is contained within an active grazing allotment and will continue to experience impacts associated with grazing,
- Climate change impacts on snowpack and the timing of snowmelt may continue to have detrimental impacts on the long-term viability of the meadow that will not be addressed through any proposed restoration actions.

Opportunities for restoration at Tyler Meadow include the following:

- The site is easily accessible by a well-developed road that allows access to the site from the east,
- A parking area adjacent to the meadow would act as an ideal staging area,
- Trees within and adjacent to the meadow may be available for use in the project,
- The site is located entirely on public land within USFS property,
- Borrow material, consisting of fine-grained material, is present in areas adjacent to the meadow if needed, and
- Late summer is characterized by little to no flow in the meadow which provides ideal conditions for construction.

Despite these opportunities for restoration, constraints to fully achieve the stated goals for a selected restoration action also need to be considered. The constraints for Tyler include the following:

- Despite the recent efforts to address erosion sources and hydrologic impacts of the adjacent road network, the continued use of the access road will provide a long-term source of increased sediment supply and discharge to the meadow,
- The meadow is contained within an active grazing allotment and will continue to experience impacts associated with grazing,
- The site is remote so any materials that need to be imported will require long-distance travel, which can raise costs, and
- Climate change impacts on snowpack and the timing of snowmelt may continue to have detrimental impacts on the long-term viability of the meadow that will not be addressed through any proposed restoration actions.

3.2 Proposed Restoration Alternatives

The following sections provide an overview of a set of restoration actions/alternatives that have been developed for each of the meadows that seeks to address the observed impacts and achieve the stated project objectives. In addition to the description of each alternative, we have attempted to provide ballpark costs associated with implementing each of the individual alternatives to inform the decision-making process. It is important to note that these cost estimates are preliminary and for planning purposes only. Similarly, the concepts are meant to be conceptual with enough detail to convey the design approach. They are not designs and will require additional analysis and field verification following selection of a preferred alternative.

3.2.1 Upper Onion Meadow Alternatives

As discussed in this report, Upper Onion Meadow is the most degraded of the three meadows within the project area as evidenced by significant channel incision. Large patches of willow do still exist throughout the meadow along with other native wet meadow patches that appear to be in moderate to good health. A meadow assessment protocol, developed by American Rivers, was utilized on the meadow by Gwen Starrett and Pat McGreevy in 2017 to grade the meadow, resulting in a score of 2, which falls within the moderately impacted classification (Table 2). Of particular concern was the apparent rapid invasion of conifers seedlings and saplings in the meadow which suggested that the incision, and associated water table lowering, was progressing to the point that the meadow was at risk.

Table 2: Meadow Assessment Scorecard results for Upper Onion.

Meadow Name	Bank Height	Gullies outside Main Channel	Bank Stability	Vegetation Condition	Bare Ground	Encroachment
Meadows rated by Starrett and McGreevy 2017						
Upper Onion Valley	2	2	2.5	2	2	2

1- heavily impacted 2 – moderately impacted 3- slightly impacted 4- natural condition

The geomorphic assessment included in this report suggested that historically, prior to disturbance, the meadow may have lacked defined channels and was primarily depositional with distributed overland flow spreading across the meadow in a low-energy condition. The challenge with restoring the meadow to that historic conditions is the fact that the hydrologic, sediment, and meadow roughness regime that maintained that condition has forever been altered, especially if there is a desire to continue to graze cattle on the meadow and maintain a road for recreation. Given these constraints, the developed alternatives provide a gradation ranging from full restoration to a Stage 0 condition to in-situ aggradation using grade control features. The following alternatives have been proposed (See Appendix A Existing Conditions Drawings for Upper Onion; See Appendix D for Preliminary Design Alternatives for Upper Onion):

- ***Alternative 1:*** This alternative consists of building a series of constructed riffles in existing, incised channels to raise the base level of the channel, encourage aggradation, reduce overall channel capacity, and raise the groundwater table. The approach would mimic what was done in the meadow in past restoration efforts but instead of using the wood and weir approach, the structure would consist of a mix of finer material borrowed from the surrounding area and coarser rock that would be imported. The spacing of the constructed riffles would vary by location based on the local slope of the channel and the presence of active headcuts. To the extent feasible, there would be no more than a 6-inch drop between each riffle resulting in a condition where the downstream riffle crest backwaters a significant portion of the tail-out material of the upstream riffle. The result would be a series of short riffles interspersed by long pools. Constructed riffles are only being proposed in existing channels that are greater than one foot depth. The starting and ending extent of each channel profile where riffles will be constructed will need to be confirmed in the field during the design phase. To control the overall base level of the meadow a roughened channel would be constructed at the moraine. The crest of the roughened channel would be constructed one foot below the adjacent moraine surface.

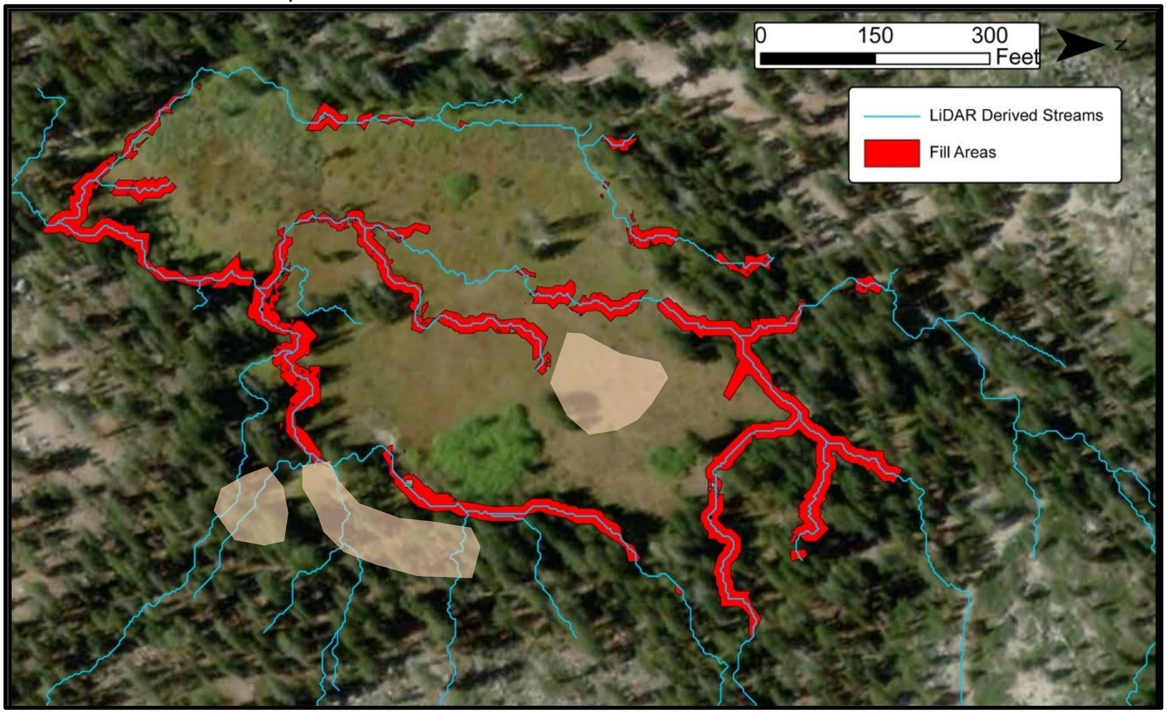
Table 3 provides a preliminary evaluation of the number of riffles and their expected spacing. This analysis was based on a field analysis that was conducted during survey of the specific profiles at the time of the field assessment. Additional analysis will be required using the survey data to provide a comprehensive assessment of the number of riffles and their specific location. Preliminary estimates identified the need for approximately 700 cubic yards of material to construct the riffles. If 30% of the material could be fines derived from on-site borrow sources, a total of 490 cubic yards of material would need to be imported. An additional 115 cubic yards of material would be required for the roughened channel.

Table 3: Preliminary assessment of constructed riffle spacing based on field interpretation of surveyed profiles.

Profile	Station Start (ft)	Station End (ft)	Total Length (ft)	Elevation Start (ft)	Elevation End (ft)	Drop (ft)	Slope	Preliminary # of Riffles	Average Riffle Spacing	Average Drop between Riffles
1	900	600	300	7453.8	7456.3	2.5	0.8%	5	60	0.5
2	750	550	200	7455.8	7458	2.2	1.1%	9	22	0.2
2	550	200	350	7458	7464	6	1.7%	9	39	0.7
3	420	100	320	7464	7467	3	0.9%	5	64	0.6
5	440	100	340	7459	7463	4	1.2%	4	85	1.0
7	750	400	350	7462	7466	4	1.1%	7	50	0.6
						Averages	**1.2%**		**53**	**0.60**

- ***Alternative 2:*** Alternative 2 represents the Stage 0 restoration condition. To restore the meadow to its historic condition all of the significant, continuous channels would be filled to a depth equal to the adjacent meadow. Periodically, higher berms in the filled channels would be constructed to ensure that the filled channel is not captured and reincised. Figure 9 provides a preliminary representation of where channels will be filled. This graphic is based on the REM map of Upper Onion Meadow that was discussed previously (Figure 5). To ensure that a headcut does not originate from downstream and reincise the meadow, this alternative will also incorporate a roughened channel at the moraine. Preliminary estimates suggest that a total of 2,200 cubic yards of fill would be required for Alternative 2 in addition to approximately 115 cubic yards of imported material for the roughened channel at the downstream end.
- ***Alternative 3:*** Alternative three consists of a hybrid between Alternative 1 and Alternative 2. The primary channels that are highly incised would receive the constructed riffle treatment discussed in Alternative 1. The remaining, smaller and/or discontinuous channels would be filled using the approach described for Alternative 2. An overview of where each treatment would occur is shown on Sheet C3 of Appendix B. Profiles where constructed riffles would occur are the lower portion of Profile 1, the lower portion of Profile 2, and most of Profiles 7 and 8. A roughened channel would be constructed at the downstream end of the project, as described in both Alternative 1 and 2. This alternative is expected to require 115 yards of imported material for the roughened channel, 700 yards of fill for the Stage 0 channels, and approximately 500 cubic yards of fill for the constructed riffles.

Figure 9: Preliminary depiction of channels in Upper Onion Meadow that would be filled to achieve a Stage 0 condition. The beige polygons represent areas that have the potential to be used to borrow material to fill the channels. Preliminary estimates suggest that these three areas would be adequate to achieve the desired fill requirements.



- ***Alternative 4:*** This alternative was identified during a discussion of the three alternatives presented above. The alternative would replace some of the constructed riffles proposed as part of Alternative 1 with log weirs to provide grade control. The advantage of using logs for a subset of the grade control features is that there is plenty of trees in and around the site that could be salvaged, thereby reducing the overall project cost. Furthermore, utilizing some of the proposed borrow areas will require removal of existing trees to allow for excavation of material for use in the constructed riffles. Logs weirs would be installed as grade control in lower energy, less incised portions of the channel network where grade control has been identified in Alternative 1. The specific areas where this would occur has not been clearly identified but could include Profile 1 upstream of the roughened channel, Profile 2 from Station 300 to 750, Profile 3, and Profile 5.

Preliminary Cost Estimate for the Upper Onion Alternatives

Preliminary cost estimates have been developed for Alternatives 1 and 2 to assist is selecting a preferred alternative (Table 4). These costs focus only on project implementation and do not include the cost of finalizing the design, obtaining regulatory permits, and providing engineering support during construction. The costs provided include a 30% contingency, given the early phase of the design. As the design progresses, additional detail and resolution will be added to the cost estimate and the ancillary cost items, discussed above, will be determined. Preliminary cost estimates for Alternatives 3 and 4 have not been developed but will be if those alternatives are selected as a preferred approach. It is expected that Alternative 3 would fall somewhere between the estimated costs for Alternatives 1 and 2. The cost for Alternative 4 is expected to be lower than the cost for Alternative 1 because the material for the log weirs would be available from on site and would not need to be purchased or imported.

TABLE 4A
THREE MEADOW RESTORATION PROJECT
ALTERNATIVES ANALYSIS LEVEL COST ESTIMATE
ALTERNATIVE 1 - UPPER ONION

Job No: 18-016 1/14/2019

ITEM NO.	ITEM	ESTIMATED QUANTITY	UNIT	UNIT COST		TOTAL
1	MOBILIZATION, SITE ACCESS, AND STAGING	1	LS	$35,000		$35,000
2	EROSION AND SEDIMENT CONTROL	1	LS	$20,000		$20,000
3	RIFFLE CONSTRUCTION					$70,700
	BORROW SITE EXCAVATION	210	CY	$20	$4,200	
	SUPPLY RIFFLE MATERIAL	490	CY	$50	$24,500	
	CONSTRUCT RIFFLES	700	CY	$60	$42,000	
4	DEWATERING	1	LS	$8,000	$8,000	$8,000
5	SEEDING	1.5	ACRE	$7,500	$11,250	$11,250
6	ROUGHENED CHANNEL	1				$12,650
	SUPPLY ROCK	115	CY	$50	$5,750	
	PLACE ROCK	115	CY	$60	$6,900	
				SUBTOTAL		$157,600
				CONTINGENCY (30%)		$47,280
				TOTAL PROJECT COST		$204,880

TABLE 4B
THREE MEADOW RESTORATION PROJECT
ALTERNATIVES ANALYSIS LEVEL COST ESTIMATE
ALTERNATIVE 2 - UPPER ONION

Job No: 18-016 1/14/2019

ITEM NO.	ITEM	ESTIMATED QUANTITY	UNIT	UNIT COST		TOTAL
1	MOBILIZATION, SITE ACCESS, AND STAGING	1	LS	$35,000		$35,000
2	EROSION AND SEDIMENT CONTROL	1	LS	$20,000		$20,000
3	CHANNEL FILLING					$99,000
	BORROW SITE EXCAVATION	2,200	CY	$20	$44,000	
	FILL CHANNELS	2,200	CY	$25	$55,000	
4	DEWATERING	1	LS	$5,000	$5,000	$5,000
5	SEEDING	3.0	ACRE	$7,500	$22,500	$22,500
6	ROUGHENED CHANNEL	1				$12,650
	SUPPLY ROCK	115	CY	$50	$5,750	
	PLACE ROCK	115	CY	$60	$6,900	
				SUBTOTAL		$194,150
				CONTINGENCY (30%)		$58,245
				TOTAL PROJECT COST		$252,395

3.2.2 High Onion Meadow Restoration Actions

Results from the meadow assessment protocol utilized on High Onion Meadow by Gwen Starrett and Pat McGreevy in 2017 resulted in a scores ranging from 1 to 3 with 1 being considered heavily impacted and 3 being slightly impacted (Table 5). These scores reflect the fact that the meadow appears to be heavily grazed but in moderately good condition outside of the main channel, which is slightly incised. These results, combined with a more thorough understanding of the geomorphic setting of the meadow relative to its condition contrasts greatly with our assessment of Upper Onion. Consequently, it is our belief that the restoration actions proposed for High Onion could entail a much lighter touch with several of the impacts being addressed through management and protection.

Table 5: Meadow Assessment Scorecard results for High Onion.

Meadow Name	Bank Height	Gullies outside Main Channel	Bank Stability	Vegetation Condition	Bare Ground	Encroachment
Meadows rated by Starrett, McGreevy, Childress and Long 2015						
High Meadow	3	3	2	1	2	3

The proposed restoration actions for High Onion Meadow include the following:

- Protect seepage sources
- Install log weir grade control structures in the primary meadow channel to limit additional downcutting
- Manage the timing and duration of grazing

It is clear from the assessment that grazing impacts should be addressed. Furthermore, we identified specific features of the meadow where exclusion of cattle would go a long way toward restoring these sensitive areas. On Sheet C1 of Appendix B (see Appendix B for Existing Conditions drawings for High Onion) six polygons were mapped during the assessment as target areas where groundwater was interacting with the surface, creating seeps, even in late summer. Where the vegetation had clearly been impacted by cattle or other ungulates, knickpoints had formed that had the potential to cause headward incision of these critical wetlands. A typical treatment to protect these seeps would be to install cattle exclusion fencing. Unfortunately, in this environment fencing is often damaged by heavy snow and would need to be taken down and reinstalled every year, which may not be feasible given limited resources to maintain these features.

In lieu of fencing, discussions with Rich Farrington and Gwen Starrett identified another potential approach to excluding cattle. This approach would consist of laying down large logs around and across the seep area(s) to discourage access by cattle. Observations of an aspen stand near Tyler Meadow suggests that where tree fall was heavy, browse by cattle decreased. Presumably this is due to the fact that the cattle do not want to step over large logs and risk injury. Adequate stands of moderately sized conifers that have encroached into the margins of High Onion Meadow could be used to accomplish this task. Further assessment will be required to determine the number of trees needed, their general configuration, and where the trees would come from, though the local source of wood appears adequate to achieve the desired objective.

Log grade control weirs would be installed at High Onion to enhance sedimentation and limit future risks of channel incision. These structures would primarily be installed at Channel Profile 3 from Station 100 to Station 600 (see Sheet C1 and C3 in Appendix B for Existing Conditions). The spacing of the structures would vary based on local channel slope but would likely be installed with an average spacing of 25 feet to account for the overall slope of 4.2% along Profile 3. This would require that approximately 20 structure be built. We anticipate that the structures could be built with hand tools and hand labor given the relatively narrow channel widths. Logs could be salvaged locally. The specifics of the spacing and a typical detail of the log weir structure will be provided during the next phase of design if this restoration action is selected.

3.2.3 Tyler Meadow Alternatives

A meadow assessment protocol utilized at Tyler Meadow by Gwen Starrett and Pat McGreevy in 2017 to resulted in scores of 2 and 4, based on the function being assessed (Table 6). The scoring, which was confirmed by our assessment, suggests that the primary impacts at the site relate to heavy grazing impacts on the meadow itself and the instability of the primary channel that discharges to the meadow. This channel, mapped as Profile 3 during the existing conditions survey (see Appendix C), is moderately incised and appears to be widening. Locally, downed wood has provided some grade control but in many cases the channel has eroded around the wood, resulting in limited benefits. A score of 2 for the Encroachment category of the assessment was due to the fact that OHV's are accessing the meadow and causing some localized impacts.

Table 6: Meadow Assessment Scorecard results for Tyler Meadow.

Meadow Name	Bank Height	Gullies outside Main Channel	Bank Stability	Vegetation Condition	Bare Ground	Encroachment
Meadows rated by Starrett and McGreevy 2017						
Tyler Meadow (Mdw_1737)	4	2	4	2	4	2

Based on this assessment, the proposed restoration actions for Tyler Meadow include the following:

- Manage the timing and duration of grazing
- Limit access by OHV's
- Install log weir grade control structures in the primary channel in the forested area upstream of the meadow to limit additional downcutting

Attempts have been made at Tyler Meadow to limit OHV access. Unfortunately, evidence of OHV use of the meadow still exists. The frequency of OHV access occurring is unknown but if OHV use occurs when the meadow is wet the impacts of that use can persist indefinitely. Current access restrictions consist of a downed log, a berm, and some boulders. Improving access restrictions will require a more detailed assessment of the site to identify where access is being gained. Long-term, boulders are most likely to be the best way to limit access. Signage to identify the meadow as sensitive habitat may also be useful at the site to educate forest users about the impact of OHV use, especially in spring and early summer when the meadow is wet and susceptible to disturbance.

Log grade control structures at Tyler Meadow would be similar in design to what is being proposed for High Onion. The difference is the fact that the channel dimensions and the level of incision at Tyler are significantly larger so it is likely that heavy equipment would be needed to construct the log weirs at Tyler. Sheet C1 in Appendix C provides locations (red dots) where our field-based assessment identified potential structure locations based on local site conditions. A total of 10 structures have been proposed with a spacing of approximately 50 feet per structure. It is anticipated that all of the logs could be salvaged from the adjacent forest. Furthermore, a flat, tree-free area follows the entire alignment of the channel within the forested area, providing good access from heavy equipment. To avoid impacts to the meadow, an access path could be created from the road. Trees removed to facilitate the access could be used in the structures.

4.0 REFERENCES

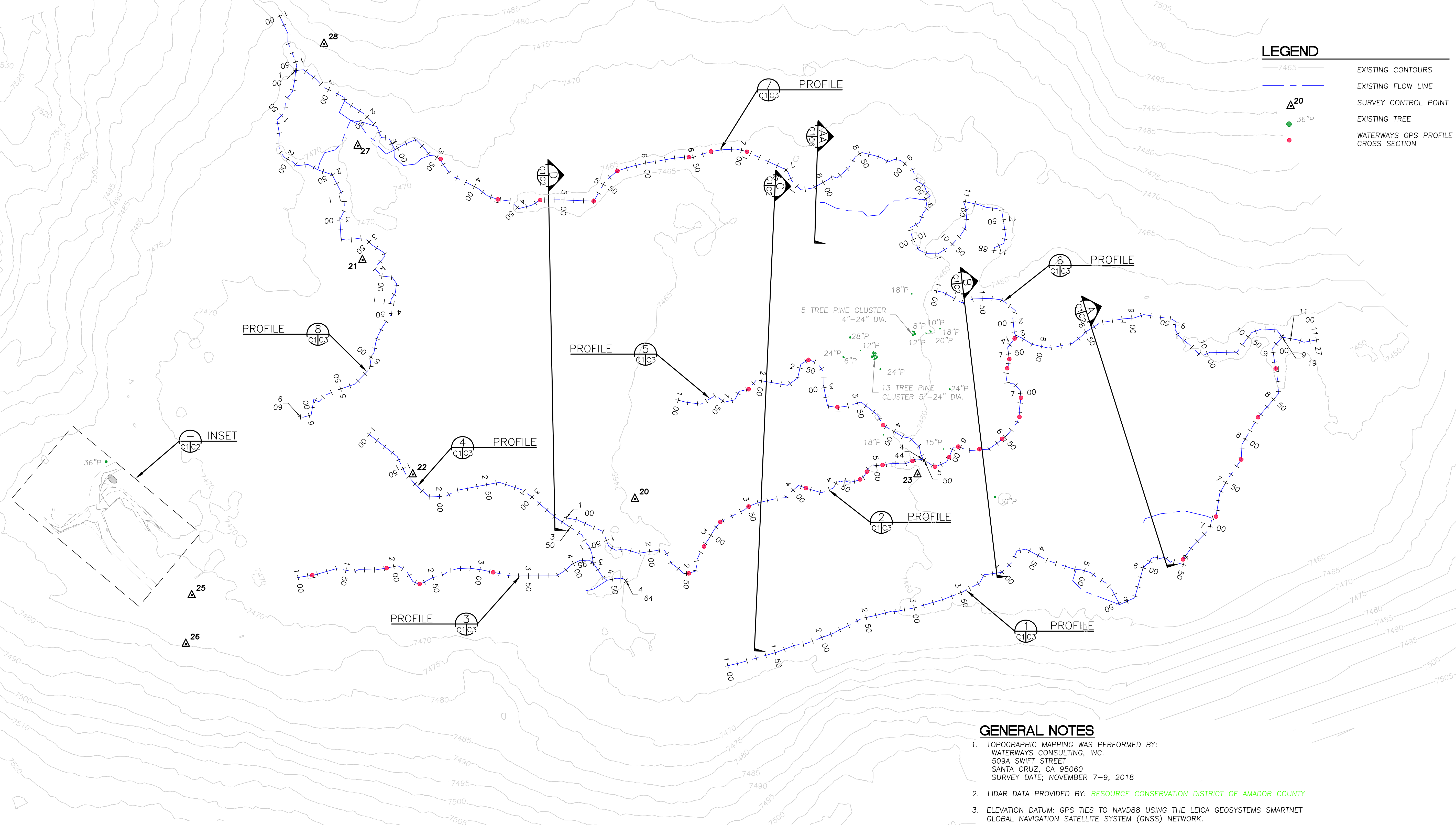
Appendix A

Existing Conditions Drawings

for

Upper Onion Meadow

SHEET INDEX



LEGEND

- EXISTING CONTOURS
- EXISTING FLOW LINE
- SURVEY CONTROL POINT
- EXISTING TREE
- WATERWAYS GPS PROFILE CROSS SECTION

GENERAL NOTES

1. TOPOGRAPHIC MAPPING WAS PERFORMED BY:
   WATERWAYS CONSULTING, INC.
   509A SWIFT STREET
   SANTA CRUZ, CA 95060
   SURVEY DATE; NOVEMBER 7–9, 2018
2. LIDAR DATA PROVIDED BY: RESOURCE CONSERVATION DISTRICT OF AMADOR COUNTY
3. ELEVATION DATUM: GPS TIES TO NAVD88 USING THE LEICA GEOSYSTEMS SMARTNET GLOBAL NAVIGATION SATELLITE SYSTEM (GNSS) NETWORK.
4. BASIS OF BEARINGS: GPS TIES TO NAD83 CALIFORNIA STATE PLANE, ZONE 3 USING THE LEICA GEOSYSTEMS SMARTNET GLOBAL NAVIGATION SATELLITE SYSTEM (GNSS) NETWORK.
5. CONTOUR INTERVAL IS FIVE FEET. ELEVATIONS AND DISTANCES SHOWN ARE IN DECIMAL FEET.
6. THIS IS NOT A BOUNDARY SURVEY. PROPERTY LINES ARE NOT SHOWN HEREON.

ABBREVIATIONS

DIA.	DIAMETER
E	EXISTING
TYP	TYPICAL

TREE SPECIES

P	LODGEPOLE PINE

SECTION AND DETAIL CONVENTION

SECTION OR DETAIL IDENTIFICATION (NUMBER OR LETTER)
5 C2 C3
REFERENCE SHEET FROM WHICH DETAIL OR SECTION IS TAKEN.
REFERENCE SHEET ON WHICH SECTION OR DETAIL IS SHOWN.

EXISTING CONDITIONS UPPER ONION SITE

SCALE: 1" = 50'

WATERWAYS CONSULTING INC.
509A SWIFT ST.
SANTA CRUZ, CA 95060
PH:(831)421-9291 // FAX:(888)819-6847
WWW.WATERWAYS.COM

DRAFT
NOT FOR CONSTRUCTION
MATT W. WELD
DATE

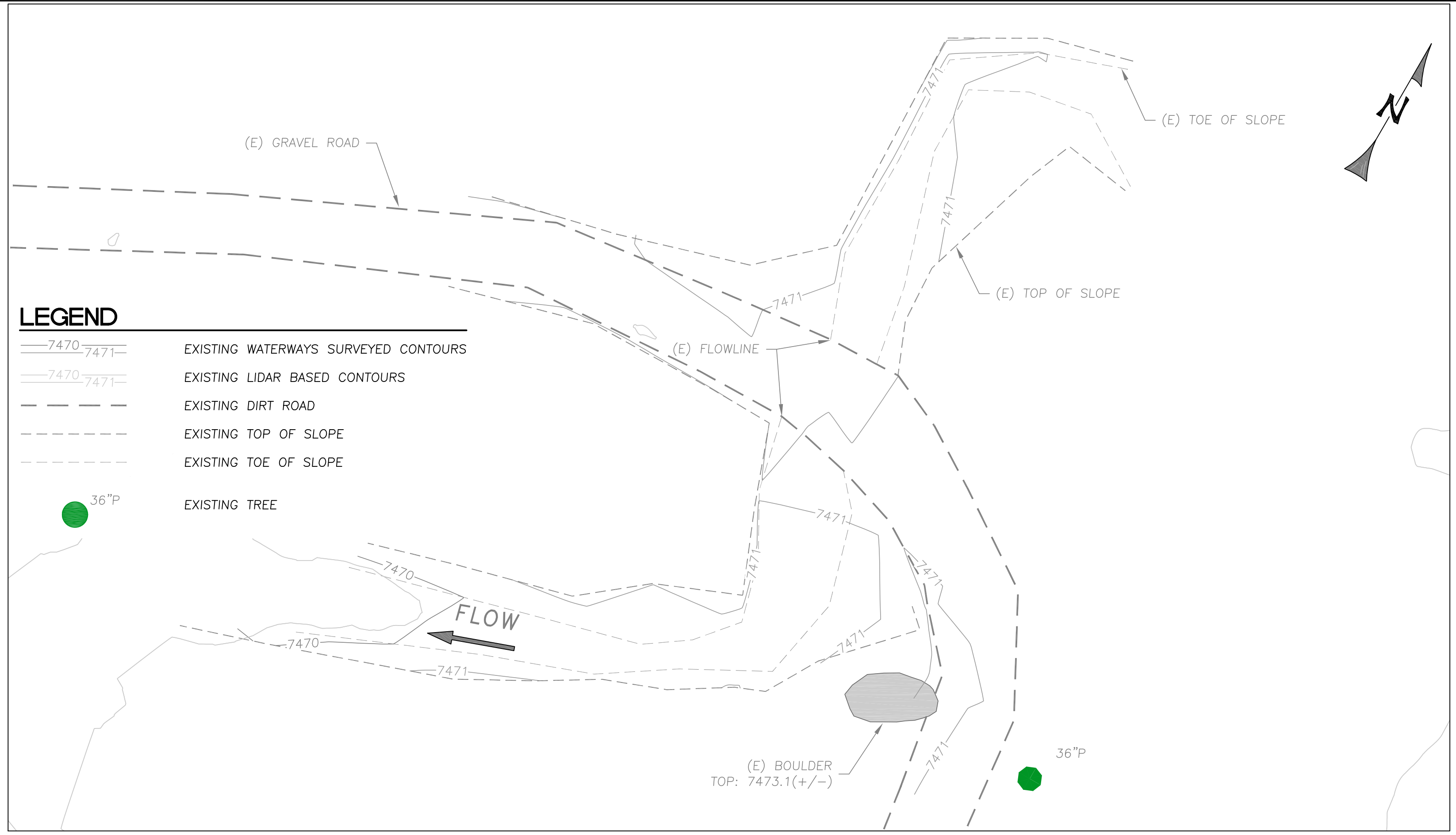
PREPARED AT THE REQUEST OF:
AMADOR RESOURCE CONSERVATION DISTRICT

EXISTING CONDITIONS UPPER ONION SITE

THREE MEADOWS RESTORATION PROJECT PHASE 1

DESIGNED BY: –
DRAWN BY: S.M.R.
CHECKED BY: –
DATE: 12/06/18
JOB NO.: 18–016

BAR IS ONE INCH ON ORIGINAL DRAWING, ADJUST SCALES FOR REDUCED PLOTS
0 1"



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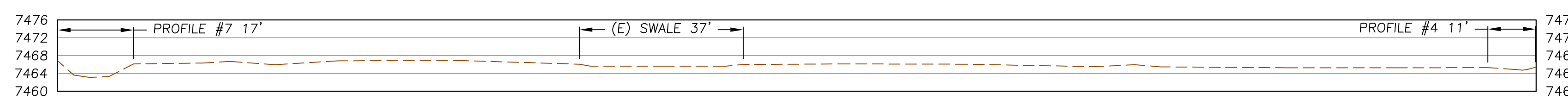

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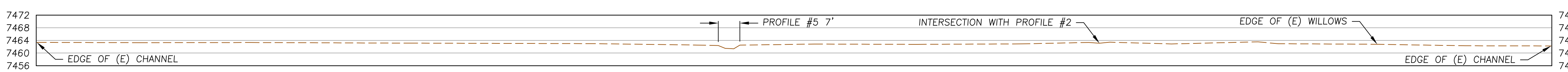
C1|C2



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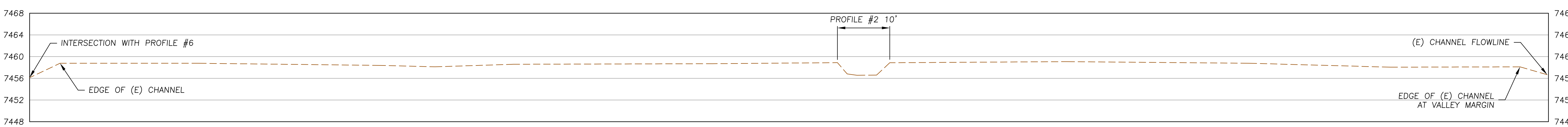

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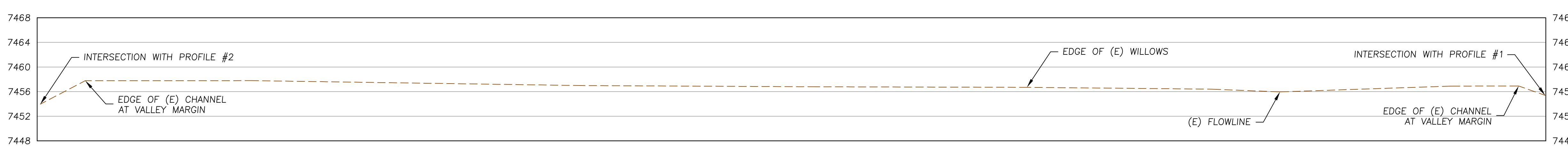

SECTION A
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C1|C2

WATERWAYS CONSULTING INC.
509A SWIFT ST.
SANTA CRUZ, CA 95060
PH:(831)421-9291 // FAX:(888)819-6847
WWW.WATERWAYS.COM

DRAFT
NOT FOR CONSTRUCTION
MATT W. WELD
DATE

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CROSS SECTIONS AND INSET UPPER ONION SITE

THREE MEADOWS RESTORATION PROJECT PHASE 1

DESIGNED BY:	–
DRAWN BY:	S.M.R.
CHECKED BY:	–
DATE:	12/06/18
JOB NO.:	18–016

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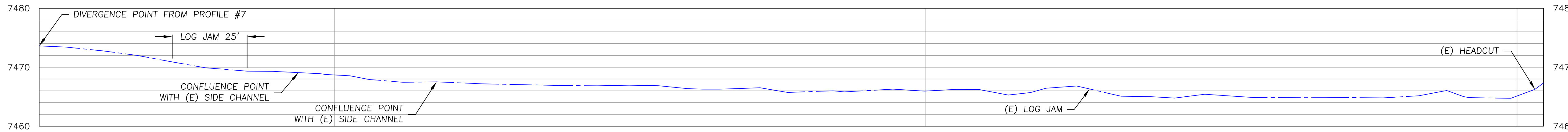
0 1"

C2
2 OF 6



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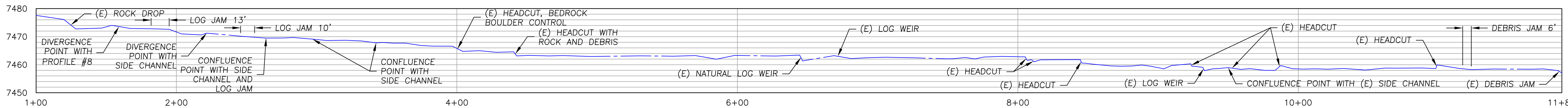

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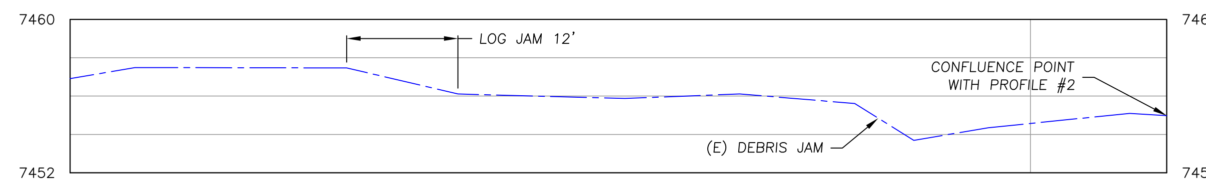

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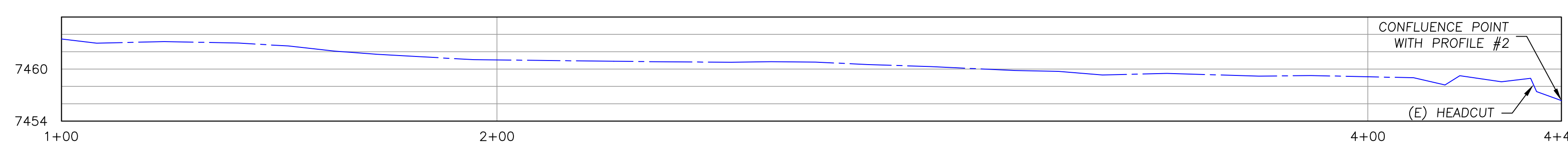

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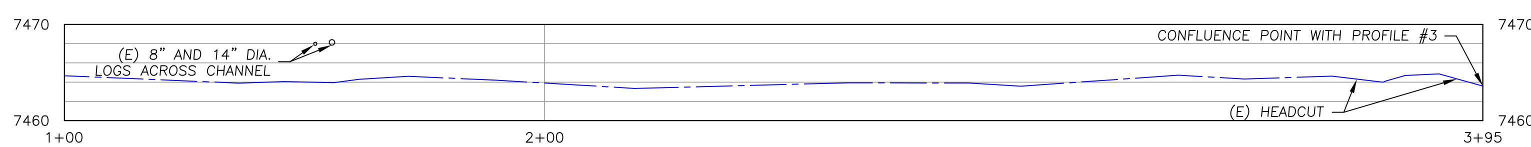

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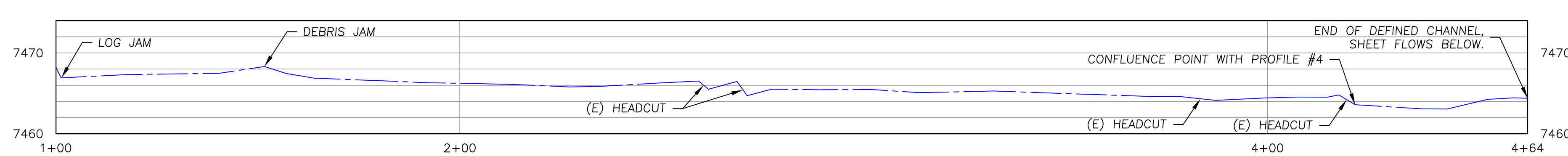

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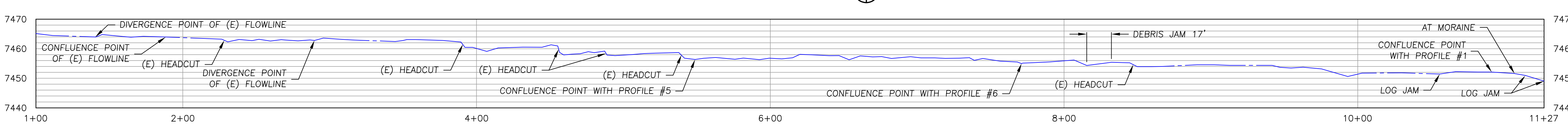

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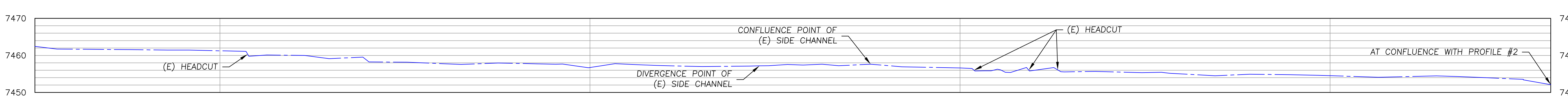

PROFILE 1 C1 C3
SCALE: 1" = 30'H 1" = 15'V

WATERWAYS CONSULTING INC.
509A SWIFT ST.
SANTA CRUZ, CA 95060
PH:(831)421-9291 / FAX:(888)819-6847
WWW.WATERWAYS.COM

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PROFILE VIEWS
UPPER ONION SITE

THREE MEADOWS RESTORATION PROJECT PHASE 1

DESIGNED BY: –
DRAWN BY: S.M.R.
CHECKED BY: –
DATE: 12/06/18
JOB NO.: 18–016

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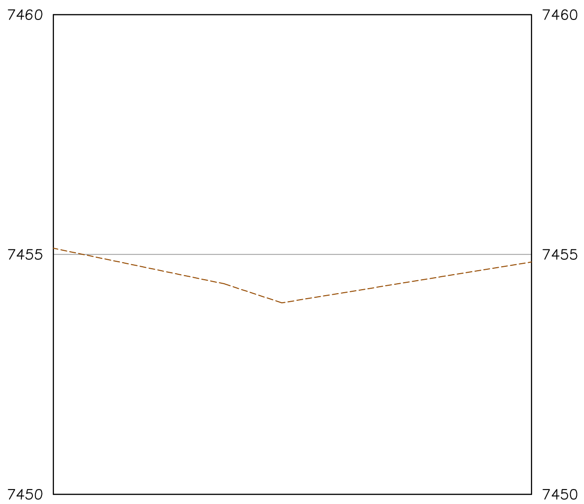
0 1"

C3



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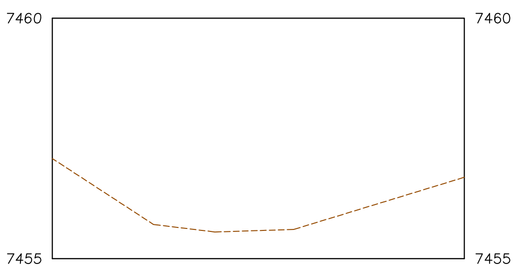

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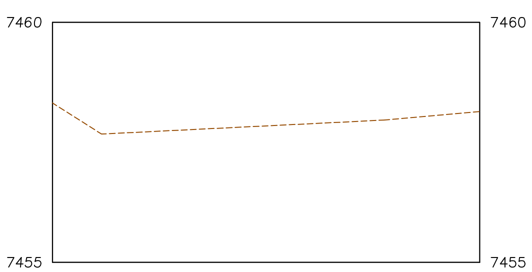

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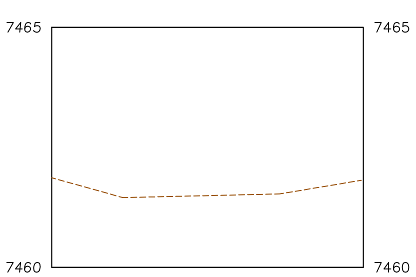

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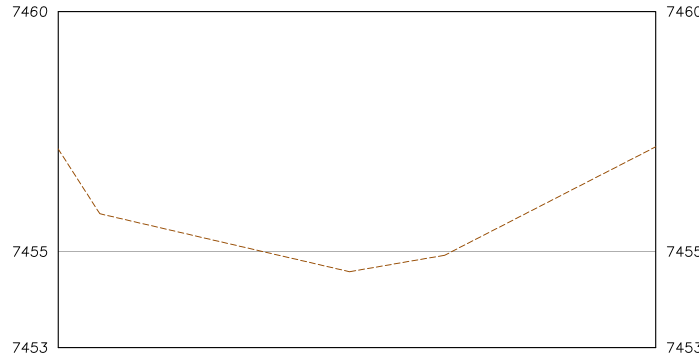

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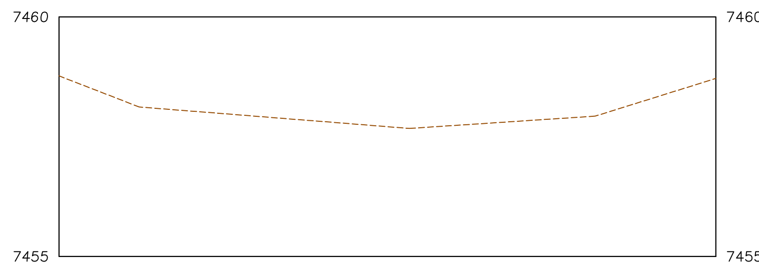

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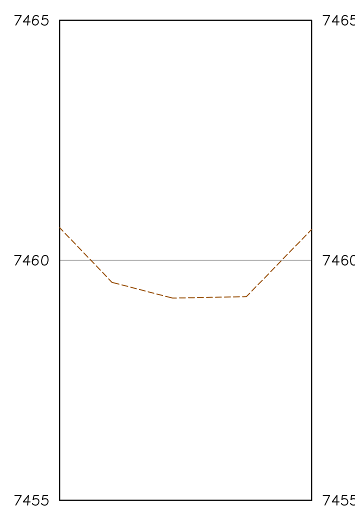

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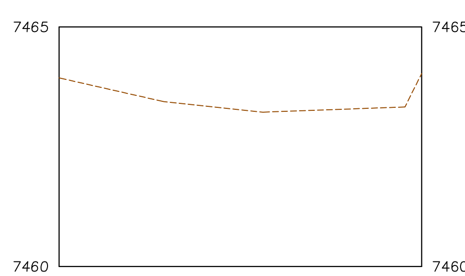

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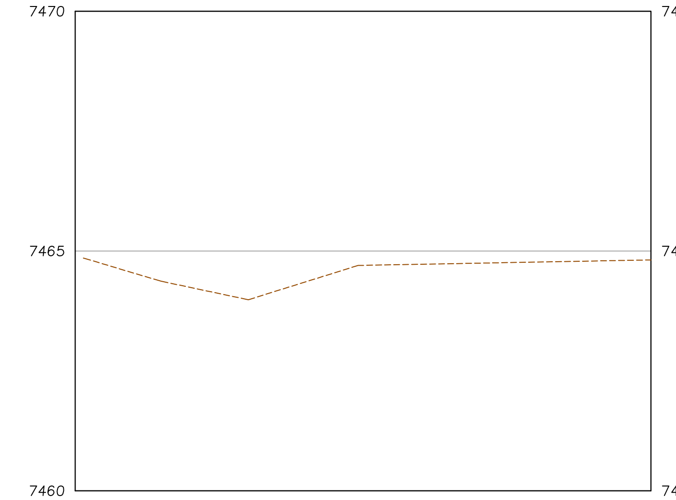

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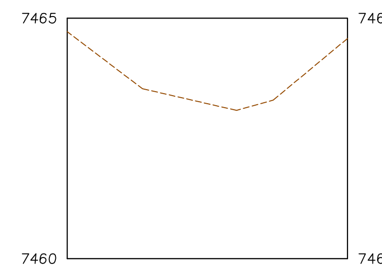

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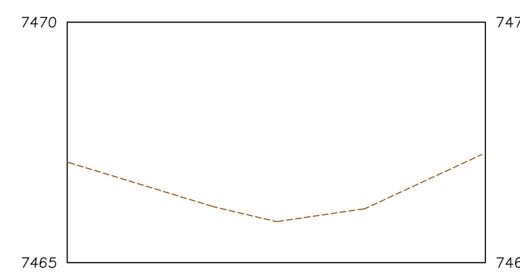

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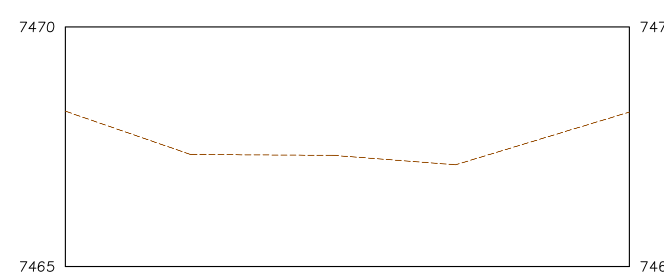

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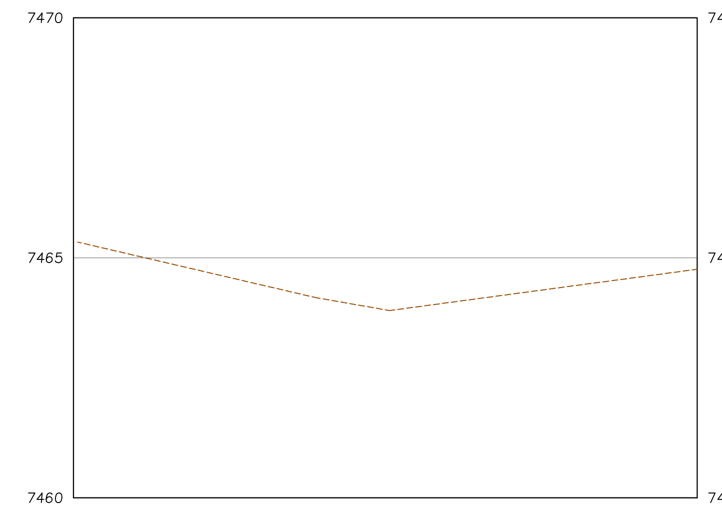

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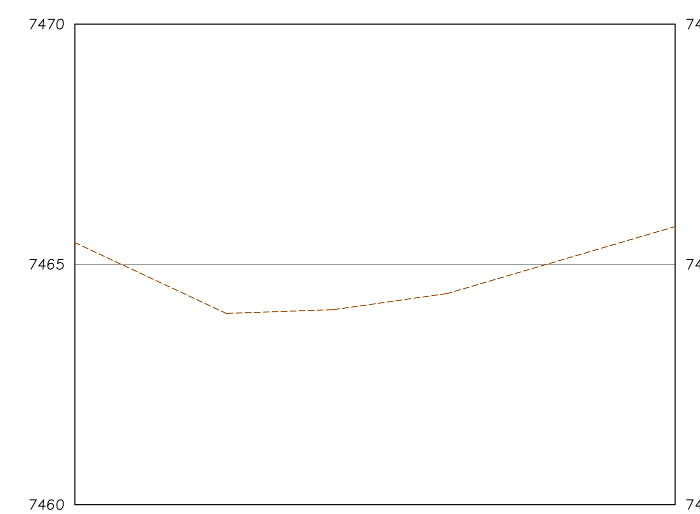

PROFILE #4 STA. 1+46.00
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509A SWIFT ST.
SANTA CRUZ, CA 95060
PH:(831)421-9291 // FAX:(888)819-6847
WWW.WATWAYS.COM

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MATT W. WELD
DATE

PREPARED AT THE REQUEST OF:
AMADOR RESOURCE CONSERVATION DISTRICT

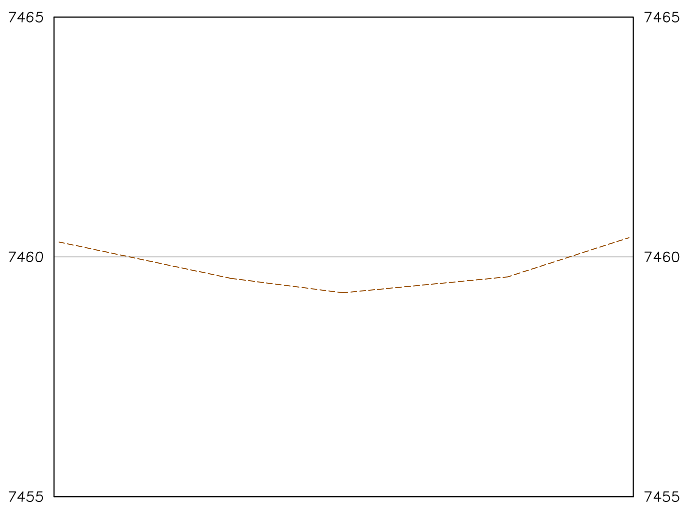
PROFILE CROSS SECTIONS UPPER ONION SITE (1 OF 3)

THREE MEADOWS RESTORATION PROJECT PHASE 1

DESIGNED BY: –
DRAWN BY: S.M.R.
CHECKED BY: –
DATE: 12/06/18
JOB NO.: 18–016

BAR IS ONE INCH ON ORIGINAL DRAWING, ADJUST SCALES FOR REDUCED PLOTS
0 1"

C4



PROFILE #5 STA. 3+87.63
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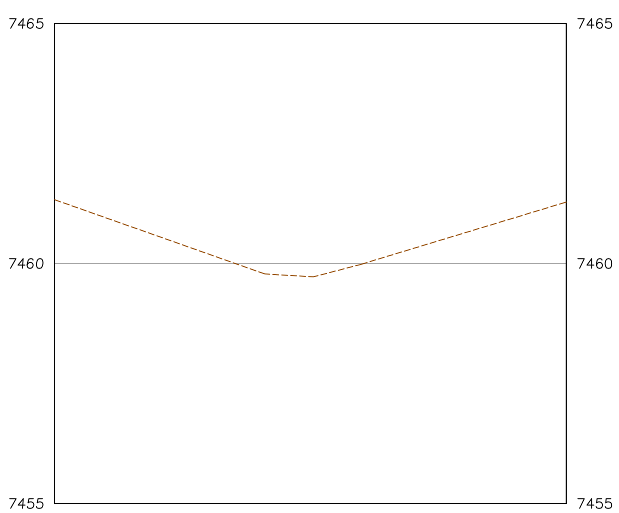

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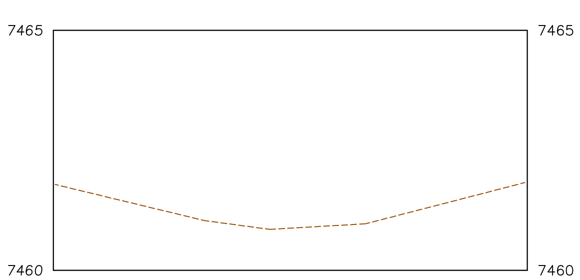

PROFILE #5 STA. 2+63.37
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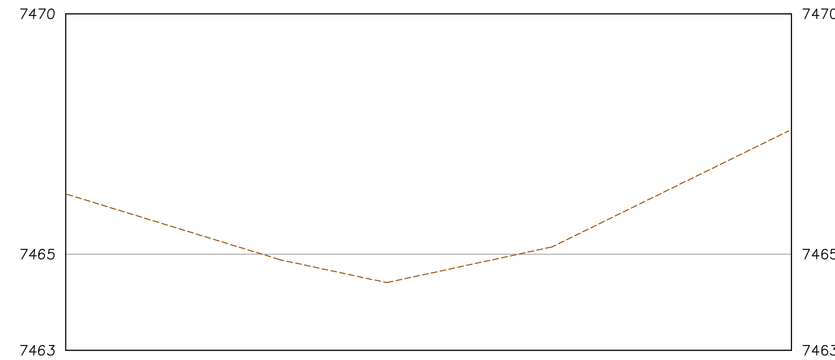

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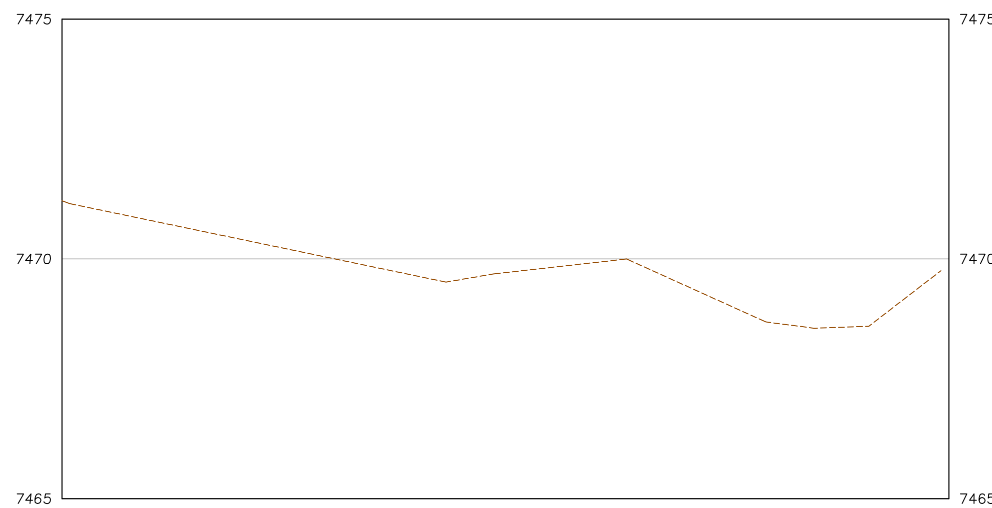

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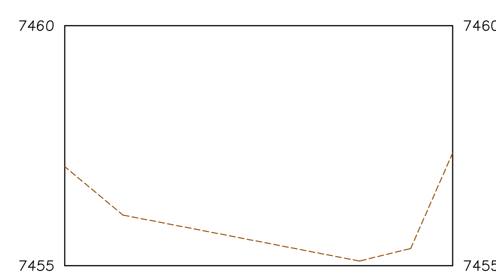

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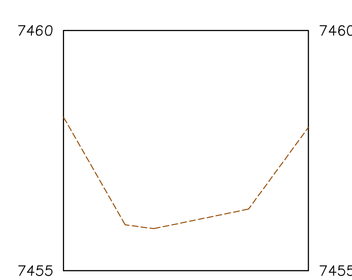

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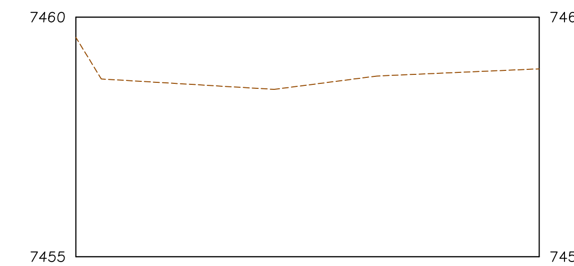

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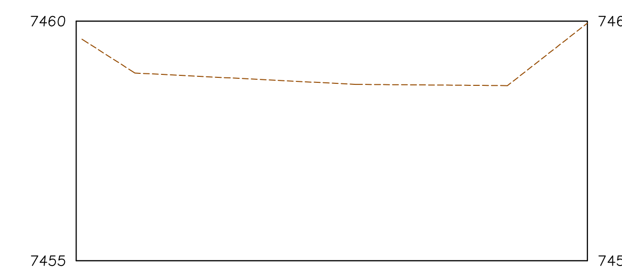

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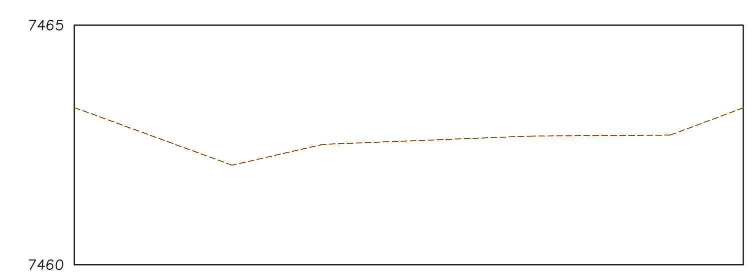

PROFILE #7 STA. 7+69.31
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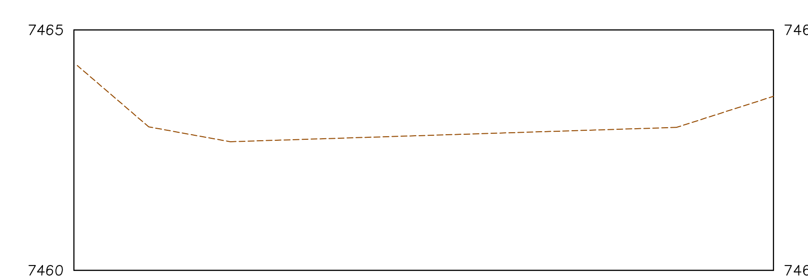

PROFILE #7 STA. 7+07.75
SCALE: 1" = 2'

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MATT W. WELD
DATE

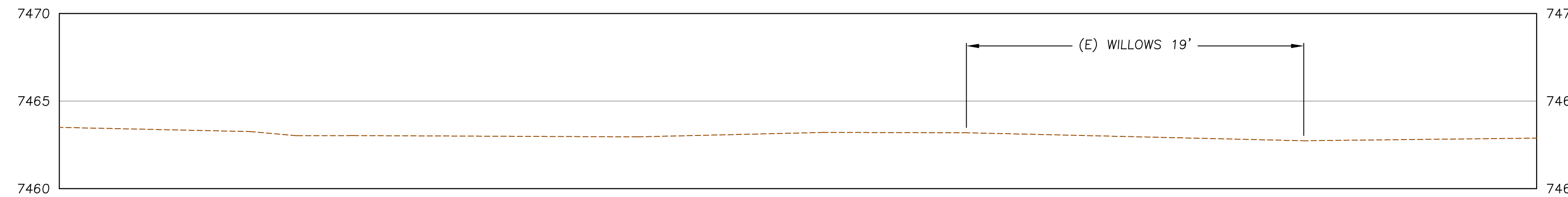
PREPARED AT THE REQUEST OF:
AMADOR RESOURCE CONSERVATION DISTRICT

PROFILE CROSS SECTIONS UPPER ONION SITE (2 OF 3)

THREE MEADOWS RESTORATION PROJECT PHASE 1

DESIGNED BY: –
DRAWN BY: S.M.R.
CHECKED BY: –
DATE: 12/06/18
JOB NO.: 18–016

BAR IS ONE INCH ON ORIGINAL DRAWING, ADJUST SCALES FOR REDUCED PLOTS
0 1"



SECTION (AA / C1 | C6)
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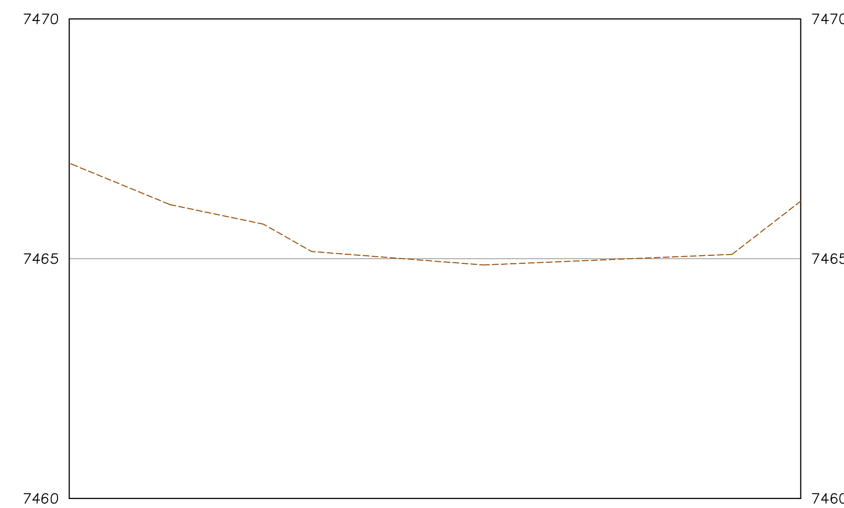

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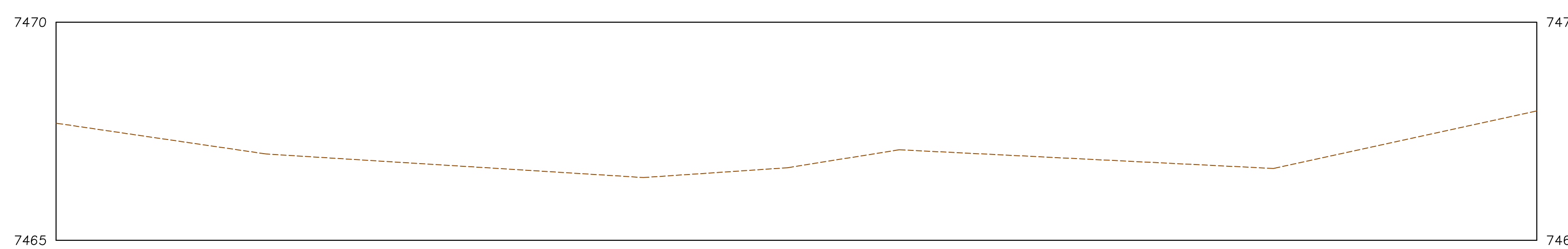

PROFILE #8 STA. 4+39.25
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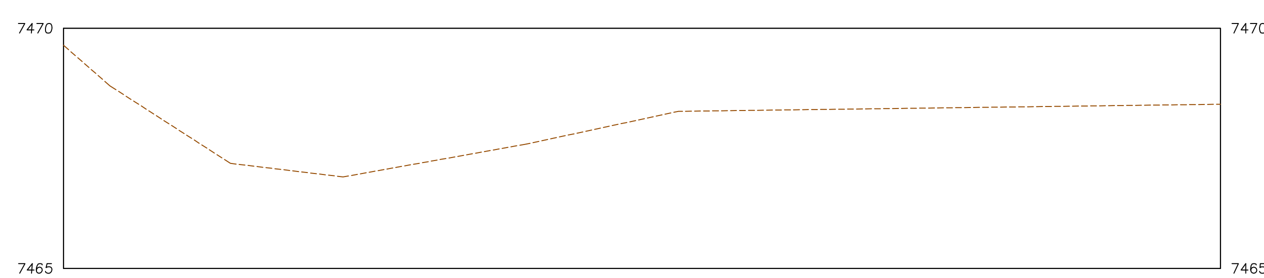

PROFILE #8 STA. 2+75.94
SCALE: 1" = 2'

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PROFILE CROSS SECTIONS UPPER ONION SITE (3 OF 3)

THREE MEADOWS RESTORATION PROJECT PHASE 1

DESIGNED BY: –
DRAWN BY: S.M.R.
CHECKED BY: –
DATE: 12/06/18
JOB NO.: 18–016

BAR IS ONE INCH ON ORIGINAL DRAWING, ADJUST SCALES FOR REDUCED PLOTS
0 1"

C6

Appendix B

Existing Conditions Drawings

for

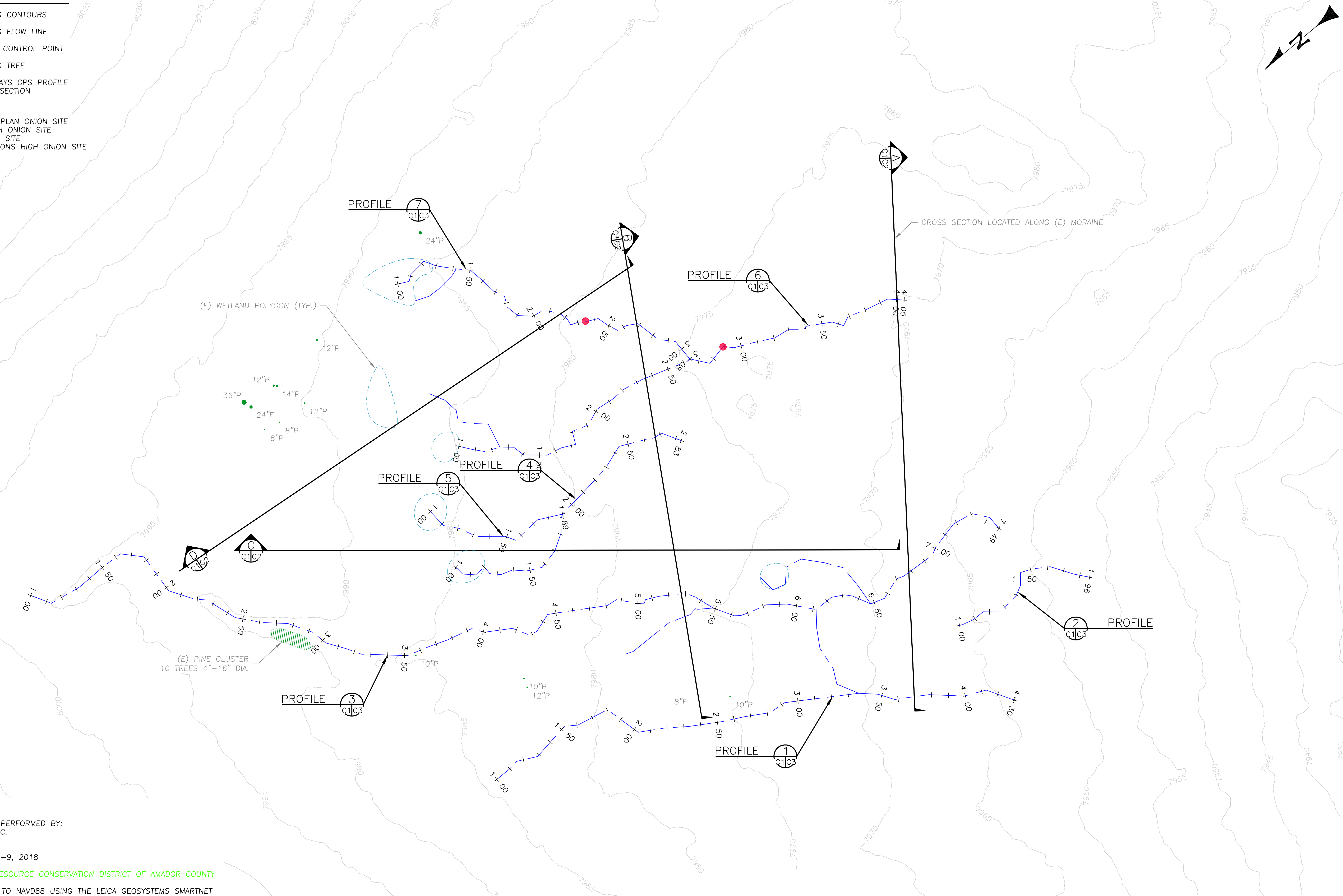
High Onion Meadow

LEGEND

7885	EXISTING CONTOURS
— —	EXISTING FLOW LINE
△30	SURVEY CONTROL POINT
● 36"P	EXISTING TREE
●	WATERWAYS GPS PROFILE CROSS SECTION

SHEET INDEX

C1	EXISTING CONDITIONS PLAN ONION SITE
C2	CROSS SECTIONS HIGH ONION SITE
C3	PROFILES HIGH ONION SITE
C4	PROFILE CROSS SECTIONS HIGH ONION SITE



ABBREVIATIONS

DIA.	DIAMETER
E	EXISTING
TYP	TYPICAL

TREE SPECIES

F	FIR
P	LODGEPOLE PINE

GENERAL NOTES

1. TOPOGRAPHIC MAPPING WAS PERFORMED BY:
   WATERWAYS CONSULTING, INC.
   509A SWIFT STREET
   SANTA CRUZ, CA 95060
   SURVEY DATE; NOVEMBER 7–9, 2018
2. LIDAR DATA PROVIDED BY: RESOURCE CONSERVATION DISTRICT OF AMADOR COUNTY
3. ELEVATION DATUM: GPS TIES TO NAVD88 USING THE LEICA GEOSYSTEMS SMARTNET GLOBAL NAVIGATION SATELLITE SYSTEM (GNSS) NETWORK.
4. BASIS OF BEARINGS: GPS TIES TO NAD83 CALIFORNIA STATE PLANE, ZONE 3 USING THE LEICA GEOSYSTEMS SMARTNET GLOBAL NAVIGATION SATELLITE SYSTEM (GNSS) NETWORK.
5. CONTOUR INTERVAL IS FIVE FEET. ELEVATIONS AND DISTANCES SHOWN ARE IN DECIMAL FEET.
6. THIS IS NOT A BOUNDARY SURVEY. PROPERTY LINES ARE NOT SHOWN HEREON.

EXISTING CONDITIONS HIGH ONION SITE

SCALE: 1" = 30'

SECTION AND DETAIL CONVENTION

SECTION OR DETAIL IDENTIFICATION (NUMBER OR LETTER)

5
C2 C3

REFERENCE SHEET FROM WHICH DETAIL OR SECTION IS TAKEN.

REFERENCE SHEET ON WHICH SECTION OR DETAIL IS SHOWN.

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SANTA CRUZ, CA 95060
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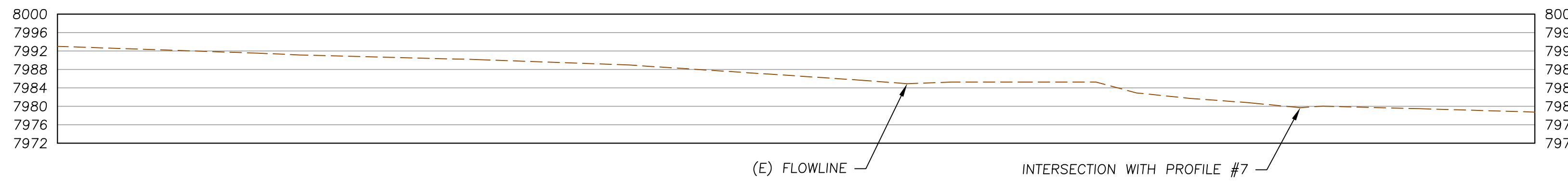
EXISTING CONDITONS PLAN
HIGH ONION SITE

THREE MEADOWS RESTORATION PROJECT PHASE 1

DESIGNED BY:	–
DRAWN BY:	S.M.R.
CHECKED BY:	–
DATE:	12/05/18
JOB NO.:	18–016

BAR IS ONE INCH ON ORIGINAL DRAWING, ADJUST SCALES FOR REDUCED PLOTS

0 1"



SECTION D C1 C2
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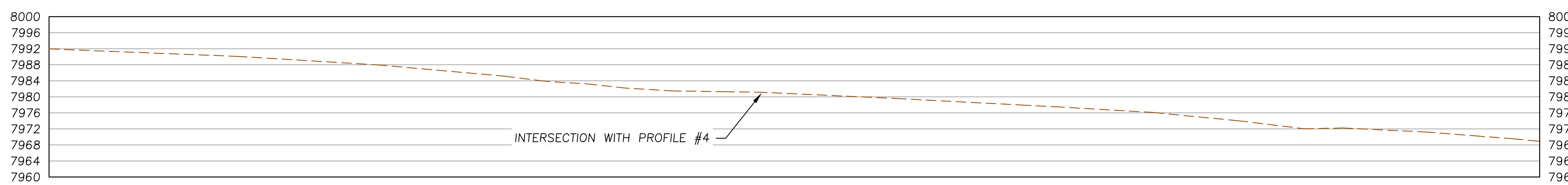

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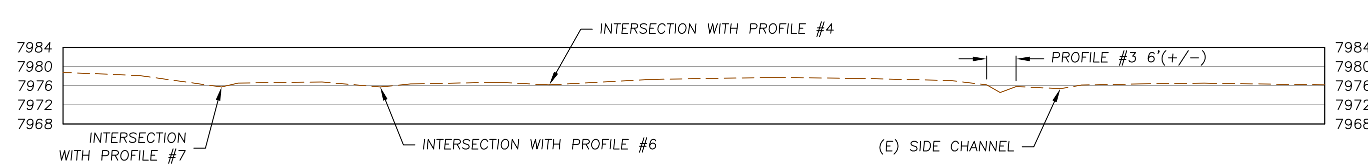

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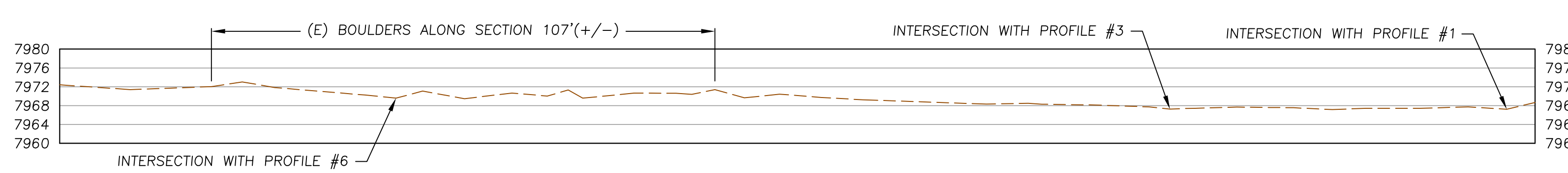

SECTION A C1 C2
SCALE: 1" = 20'

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CROSS SECTIONS HIGH ONION SITE

THREE MEADOWS RESTORATION PROJECT PHASE 1

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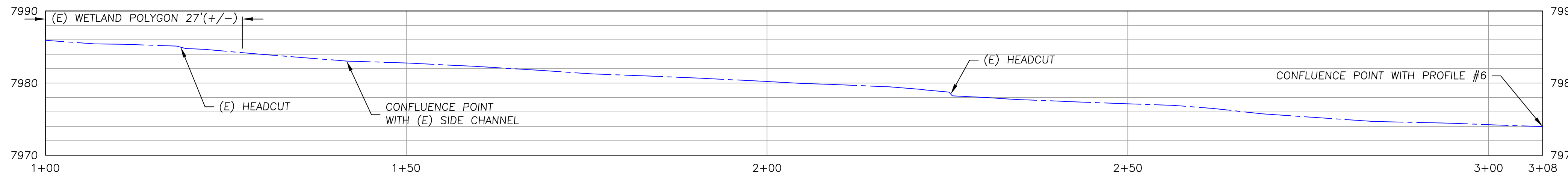
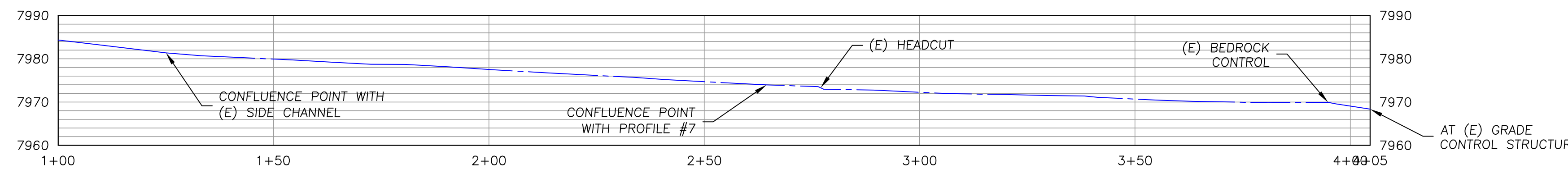
BAR IS ONE INCH ON ORIGINAL DRAWING, ADJUST SCALES FOR REDUCED PLOTS
0 1"

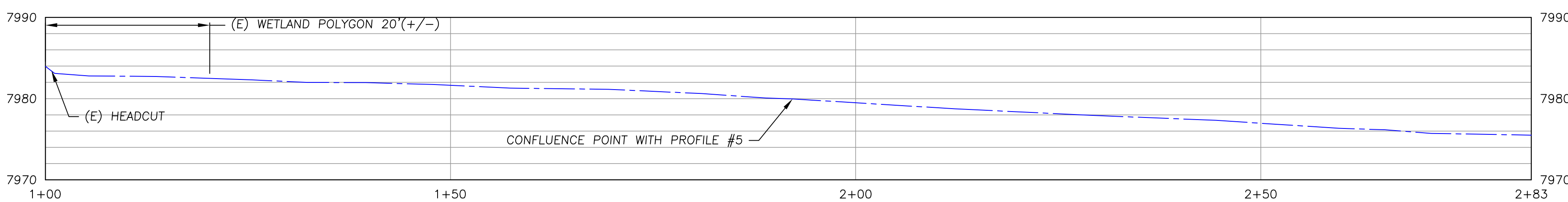
C2



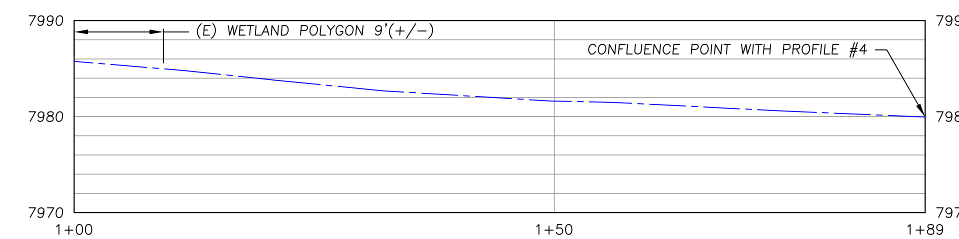
PROFILE
SCALE: 1" = 10'
7 C1|C3



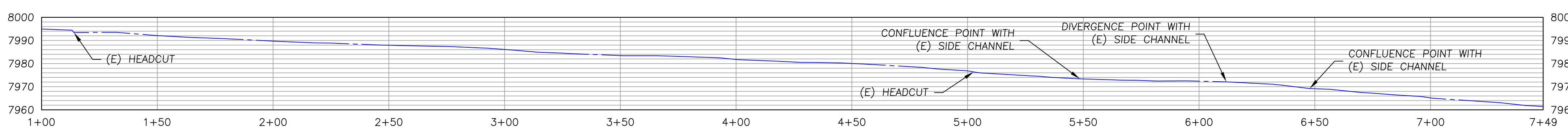
PROFILE
SCALE: 1" = 20'
6 C1|C3



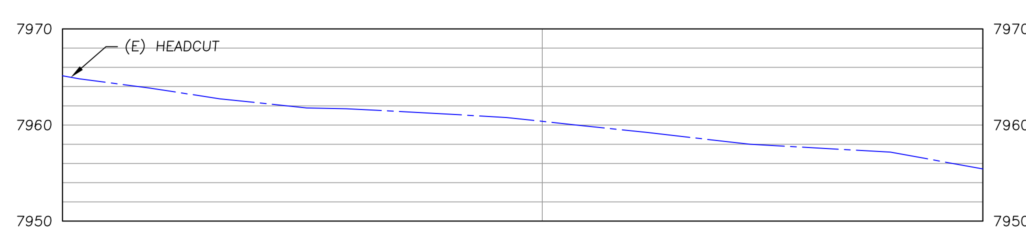
PROFILE
SCALE: 1" = 10'
4 C1|C3



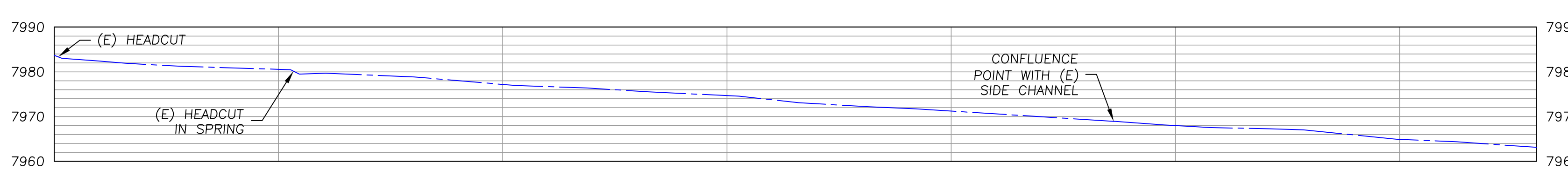
PROFILE
SCALE: 1" = 10'
5 C1|C3



PROFILE
SCALE: 1" = 30'
3 C1|C3



PROFILE
SCALE: 1" = 10'
2 C1|C3



PROFILE
SCALE: 1" = 20'
1 C1|C3

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PROFILES
HIGH ONION SITE

THREE MEADOWS RESTORATION PROJECT PHASE 1

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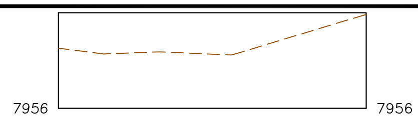
JOB NO.: 18–016

BAR IS ONE INCH ON ORIGINAL DRAWING, ADJUST SCALES FOR REDUCED PLOTS
0 1"

C3
3 OF 4



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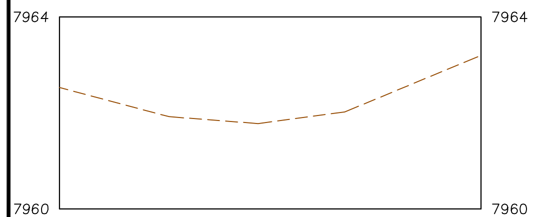

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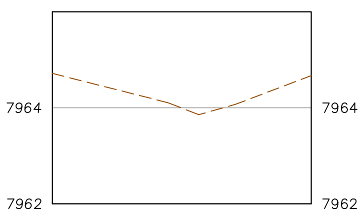

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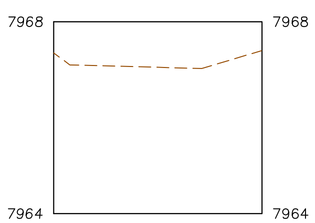

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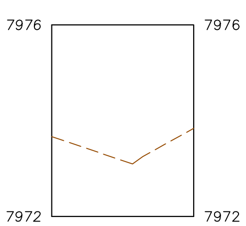

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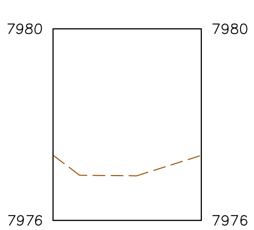

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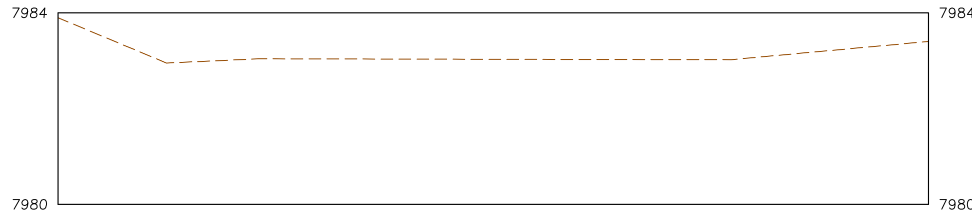

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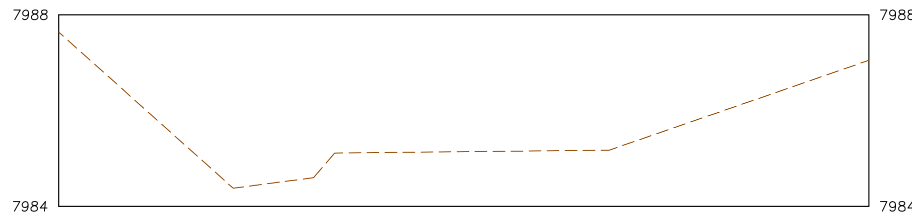

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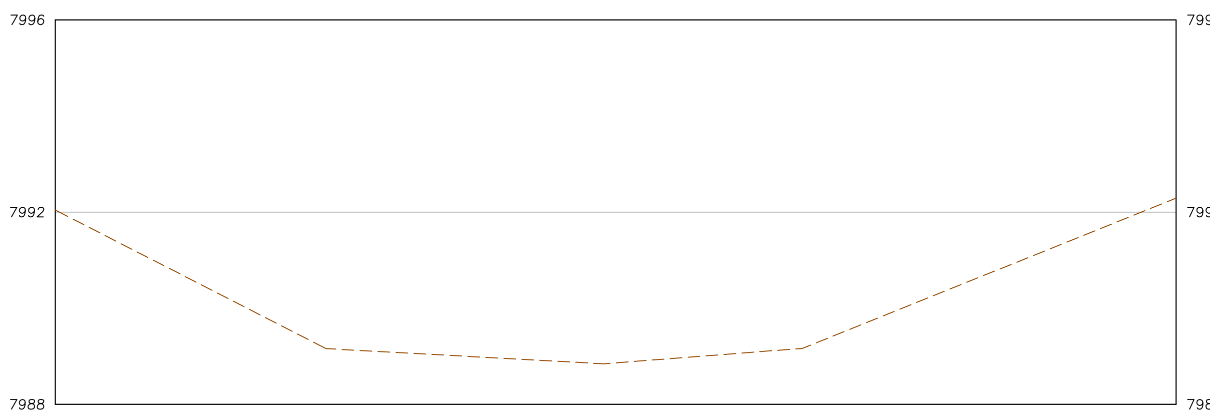

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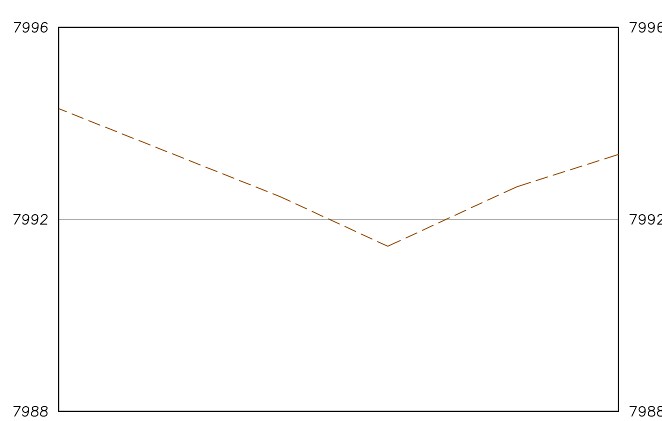

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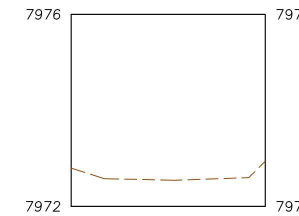

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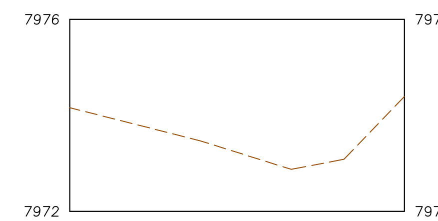

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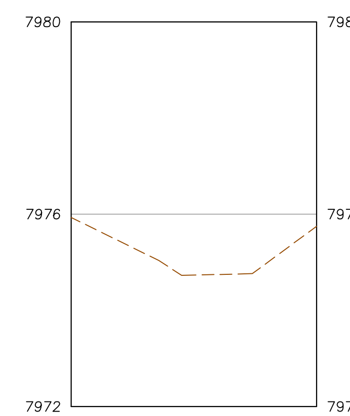

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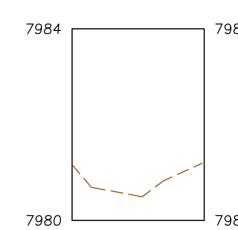

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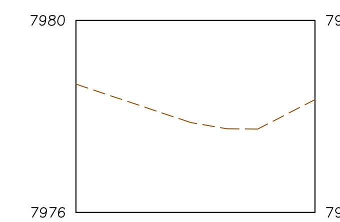

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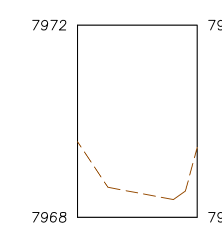

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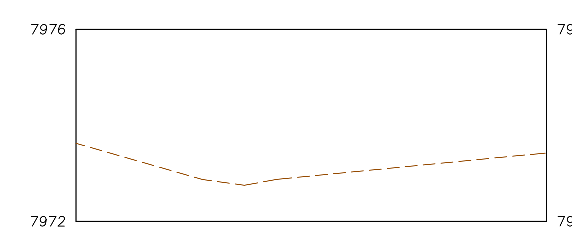

PROFILE #6 STA. 2+88.41
SCALE: 1" = 2'

PROFILE CROSS SECTIONS
SCALE: 1" = 2'

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PROFILE CROSS SECTIONS
HIGH ONION SITE

THREE MEADOWS RESTORATION PROJECT PHASE 1

DESIGNED BY: –
DRAWN BY: S.M.R.
CHECKED BY: –
DATE: 12/05/18
JOB NO.: 18–016

BAR IS ONE INCH ON ORIGINAL DRAWING, ADJUST SCALES FOR REDUCED PLOTS
0 1"

C4

Appendix C

Existing Conditions Drawings

for

Tyler Meadow

LEGEND

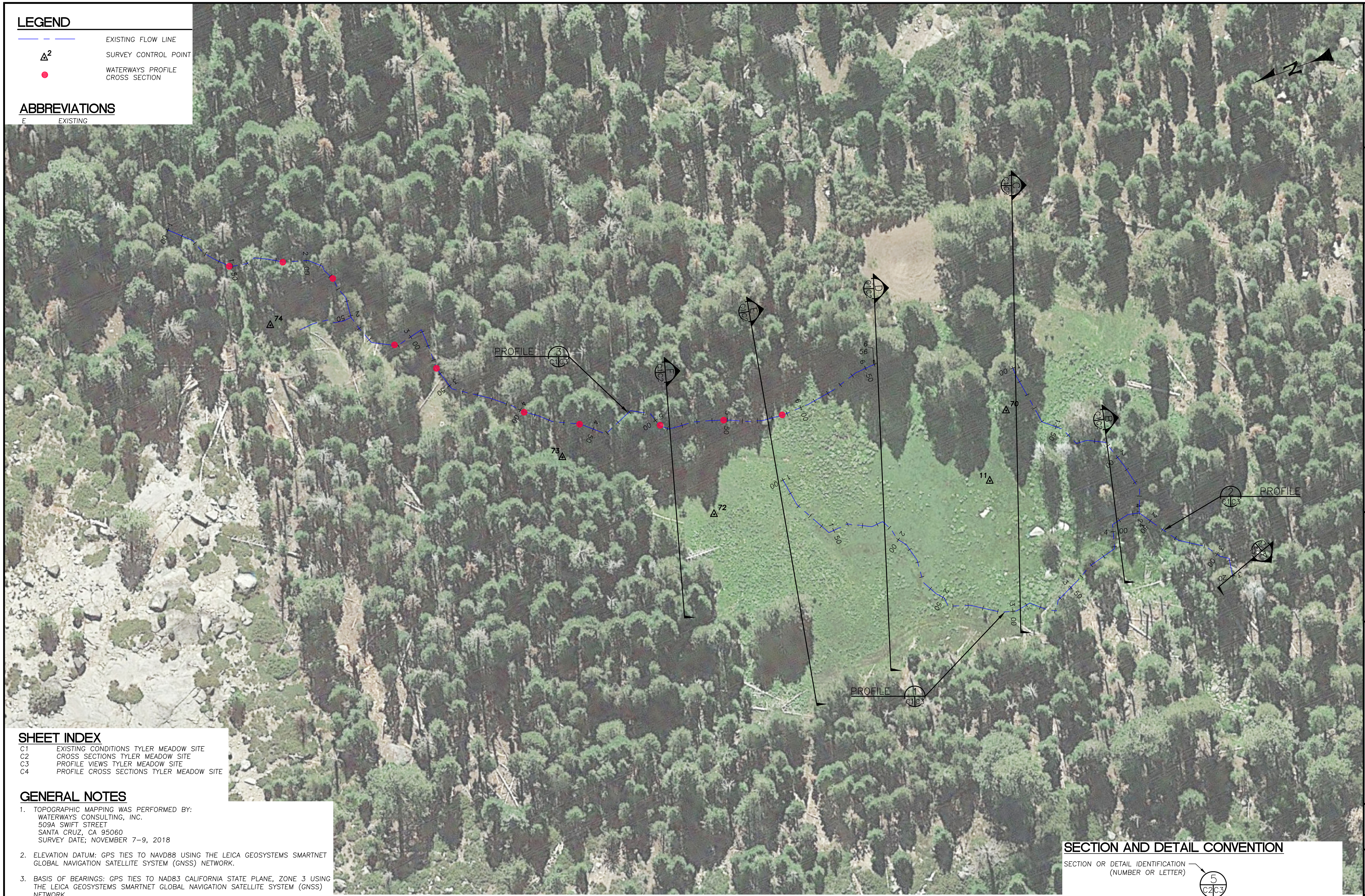
EXISTING FLOW LINE

SURVEY CONTROL POINT

WATERWAYS PROFILE CROSS SECTION

ABBREVIATIONS

E EXISTING



SHEET INDEX

GENERAL NOTES

1. TOPOGRAPHIC MAPPING WAS PERFORMED BY:
   WATERWAYS CONSULTING, INC.
   509A SWIFT STREET
   SANTA CRUZ, CA 95060
   SURVEY DATE; NOVEMBER 7–9, 2018
2. ELEVATION DATUM: GPS TIES TO NAVD88 USING THE LEICA GEOSYSTEMS SMARTNET GLOBAL NAVIGATION SATELLITE SYSTEM (GNSS) NETWORK.
3. BASIS OF BEARINGS: GPS TIES TO NAD83 CALIFORNIA STATE PLANE, ZONE 3 USING THE LEICA GEOSYSTEMS SMARTNET GLOBAL NAVIGATION SATELLITE SYSTEM (GNSS) NETWORK.
4. THIS IS NOT A BOUNDARY SURVEY. PROPERTY LINES ARE NOT SHOWN HEREON.

EXISTING CONDITIONS TYLER MEADOW SITE

SCALE: 1" = 30'

SECTION AND DETAIL CONVENTION

SECTION OR DETAIL IDENTIFICATION (NUMBER OR LETTER)

5
C2 C3

REFERENCE SHEET FROM WHICH DETAIL OR SECTION IS TAKEN.

REFERENCE SHEET ON WHICH SECTION OR DETAIL IS SHOWN.

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EXISTING CONDITIONS TYLER MEADOW SITE

THREE MEADOWS RESTORATION PROJECT PHASE 1

DESIGNED BY:	–
DRAWN BY:	S.M.R.
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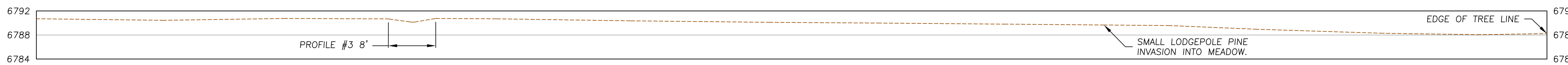
JOB NO.:	18–016

BAR IS ONE INCH ON ORIGINAL DRAWING, ADJUST SCALES FOR REDUCED PLOTS

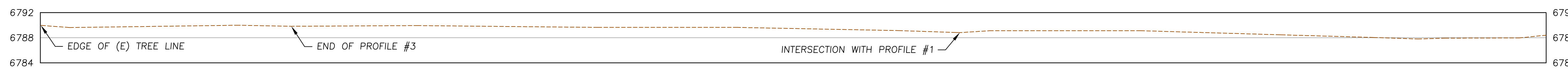
0 1"

C1

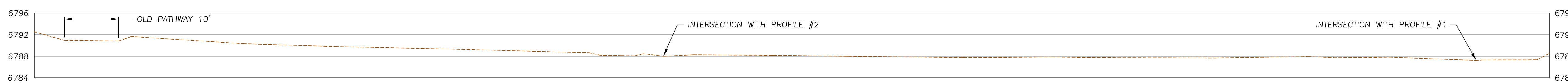
SECTION F C1 C2
SCALE: 1" = 10'



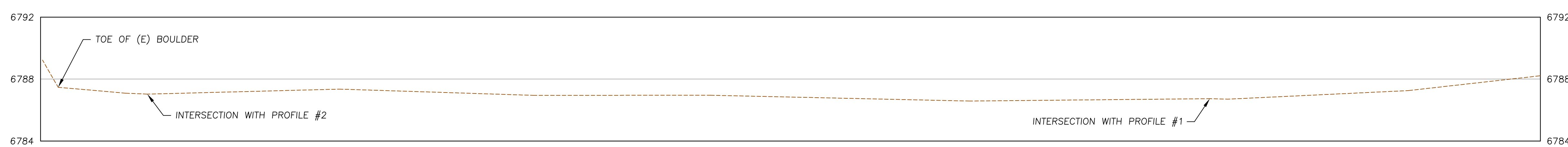
SECTION E C1 C2
SCALE: 1" = 10'



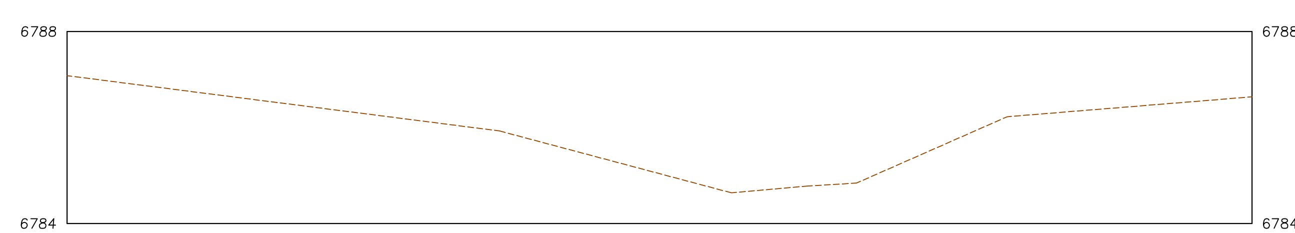
SECTION D C1 C2
SCALE: 1" = 10'



SECTION C C1 C2
SCALE: 1" = 10'



SECTION B C1 C2
SCALE: 1" = 4'



SECTION A C1 C2
SCALE: 1" = 2'

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SANTA CRUZ, CA 95060
PH:(831)421-9291 // FAX:(888)819-6847
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PREPARED AT THE REQUEST OF:
AMADOR RESOURCE CONSERVATION DISTRICT

CROSS SECTIONS
TYLER MEADOW SITE

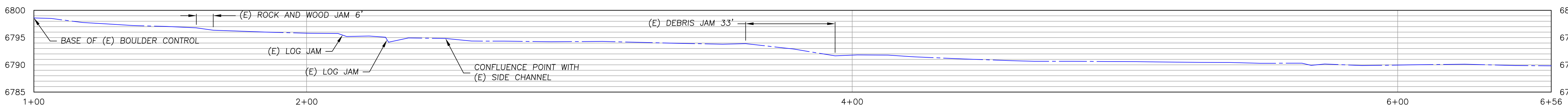
THREE MEADOWS RESTORATION PROJECT PHASE 1

DESIGNED BY:	–
DRAWN BY:	S.M.R.
CHECKED BY:	–
DATE:	12/05/18
JOB NO.:	18–016

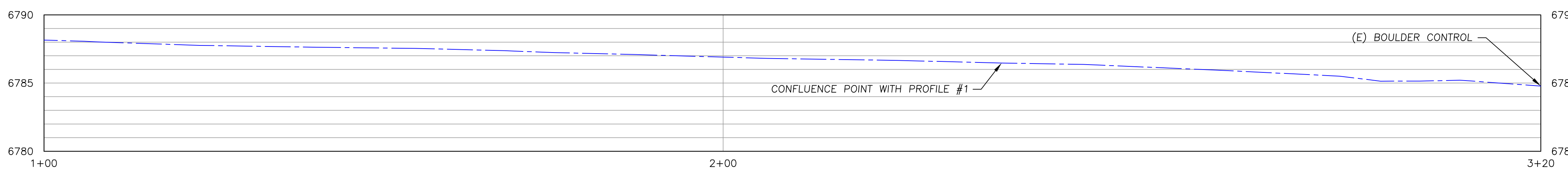
BAR IS ONE INCH ON ORIGINAL DRAWING, ADJUST SCALES FOR REDUCED PLOTS
0 1"

C2

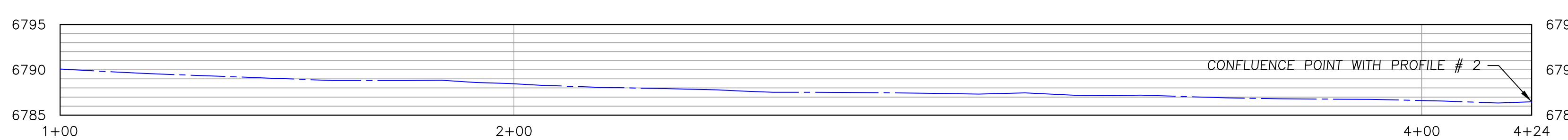
2 OF 4



PROFILE 3 C1 C3
SCALE: 1" = 20'H ; 1" = 10' V



PROFILE 2 C1 C3
SCALE: 1" = 10'H ; 1" = 5' V



PROFILE 1 C1 C3
SCALE: 1" = 20'H ; 1" =10' V

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PREPARED AT THE REQUEST OF:
AMADOR RESOURCE CONSERVATION DISTRICT

PROFILE VIEWS TYLER MEADOW SITE

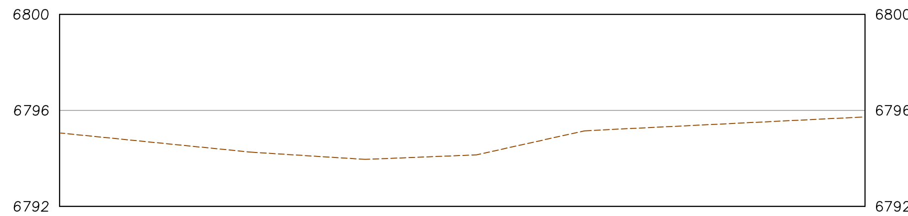
THREE MEADOWS RESTORATION PROJECT PHASE 1

DESIGNED BY:	–
DRAWN BY:	S.M.R.
CHECKED BY:	–
DATE:	12/05/18
JOB NO.:	18–016

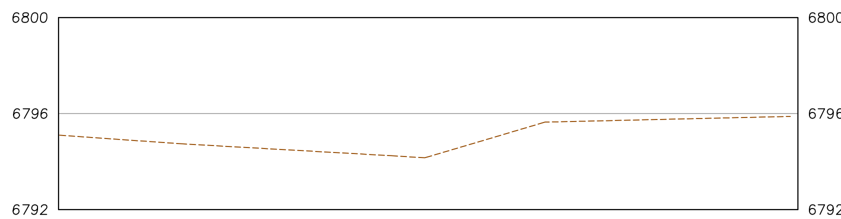
BAR IS ONE INCH ON ORIGINAL DRAWING, ADJUST SCALES FOR REDUCED PLOTS
0 1"

C3

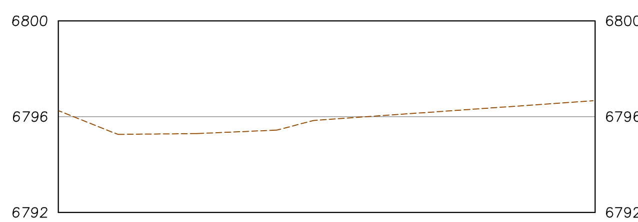
3 OF 4



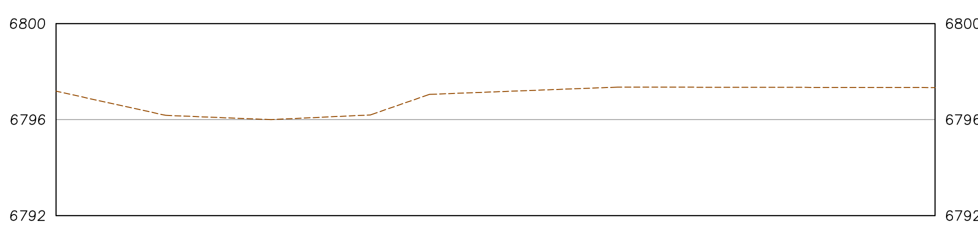
PROFILE #3 STA. 3+35.78
SCALE: 1" = 4'



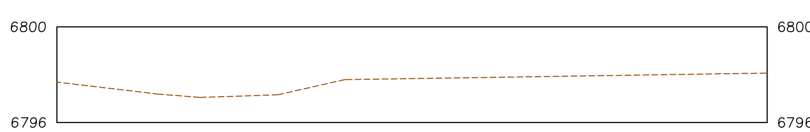
PROFILE #3 STA. 2+86.77
SCALE: 1" = 4'



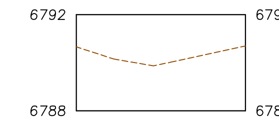
PROFILE #3 STA. 2+21.90
SCALE: 1" = 4'



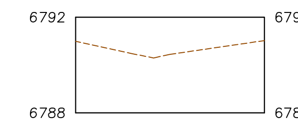
PROFILE #3 STA. 1+83.61
SCALE: 1" = 4'



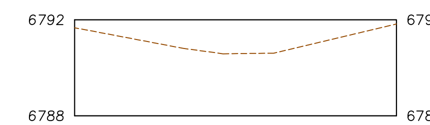
PROFILE #3 STA. 1+47.37
SCALE: 1" = 4'



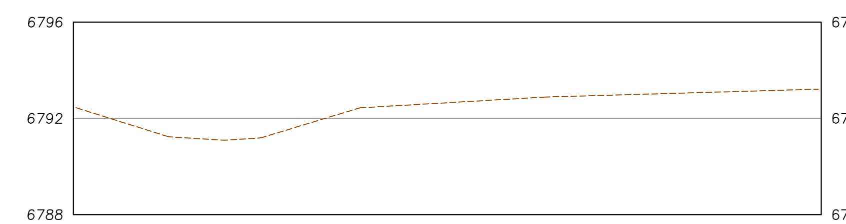
PROFILE #3 STA. 5+86.54
SCALE: 1" = 4'



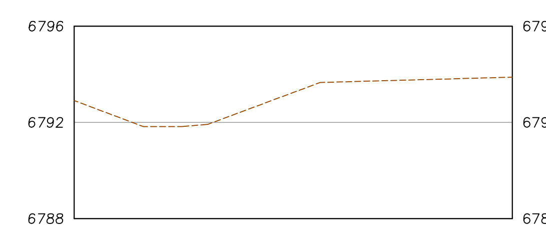
PROFILE #3 STA. 5+49.44
SCALE: 1" = 4'



PROFILE #3 STA. 5+04.61
SCALE: 1" = 4'



PROFILE #3 STA. 4+40.62
SCALE: 1" = 4'



PROFILE #3 STA. 4+02.81
SCALE: 1" = 4'

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PREPARED AT THE REQUEST OF:
AMADOR RESOURCE CONSERVATION DISTRICT

PROFILE CROSS SECTIONS TYLER MEADOW SITE

THREE MEADOWS RESTORATION PROJECT PHASE 1

DESIGNED BY: –
DRAWN BY: S.M.R.
CHECKED BY: –
DATE: 12/05/18
JOB NO.: 18–016

BAR IS ONE INCH ON ORIGINAL DRAWING, ADJUST SCALES FOR REDUCED PLOTS
0 1"

C4

4 OF 4

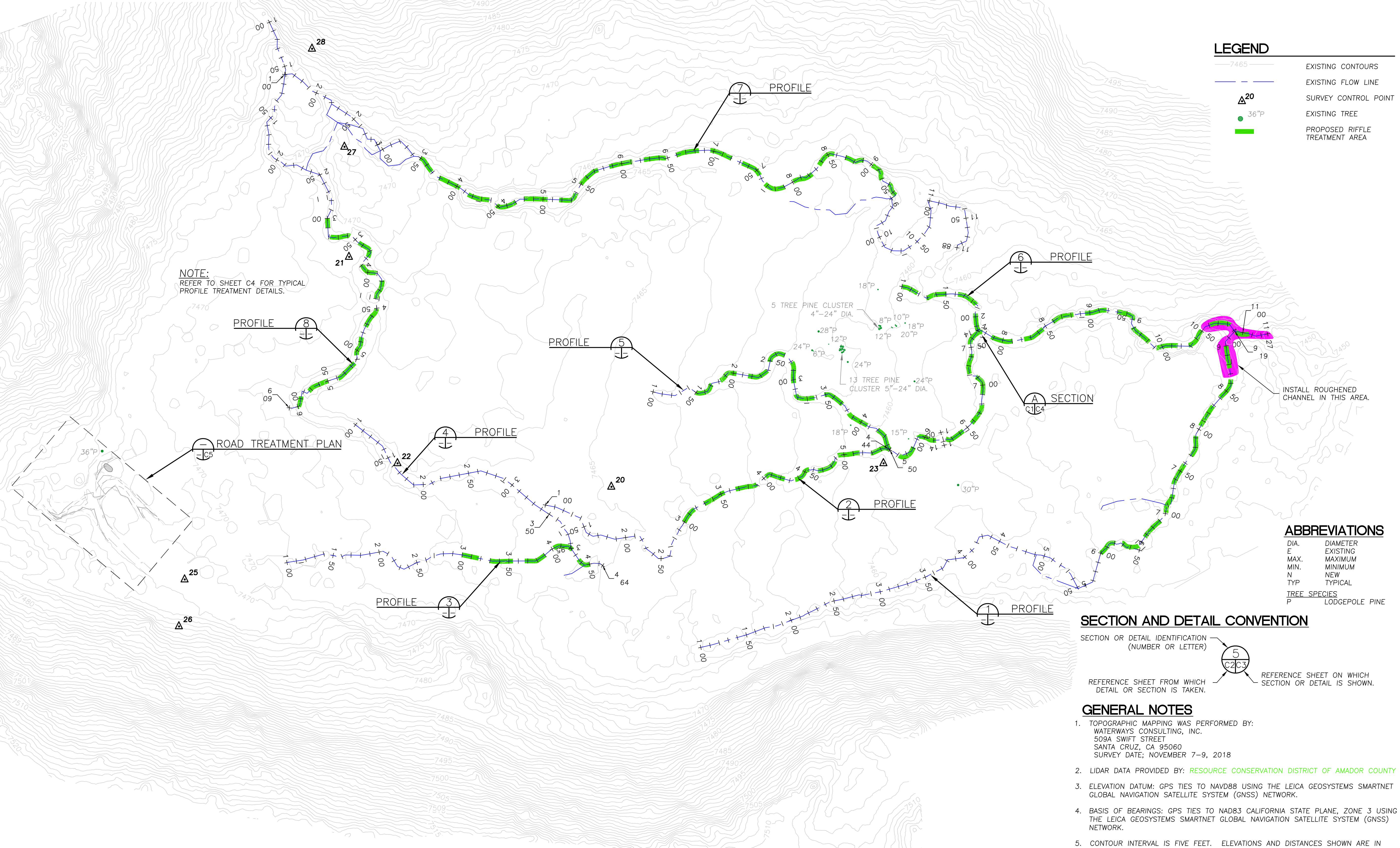
Appendix D

Preliminary Design Alternatives

for

Upper Onion

SHEET INDEX



LEGEND

7465	EXISTING CONTOURS
	EXISTING FLOW LINE
20	SURVEY CONTROL POINT
36"P	EXISTING TREE
	PROPOSED RIFFLE TREATMENT AREA

ABBREVIATIONS

DIA.	DIAMETER
E	EXISTING
MAX.	MAXIMUM
MIN.	MINIMUM
N	NEW
TYP	TYPICAL
TREE SPECIES	
P	LODGEPOLE PINE

SECTION AND DETAIL CONVENTION

SECTION OR DETAIL IDENTIFICATION (NUMBER OR LETTER)

REFERENCE SHEET FROM WHICH DETAIL OR SECTION IS TAKEN.

REFERENCE SHEET ON WHICH SECTION OR DETAIL IS SHOWN.

GENERAL NOTES

1. TOPOGRAPHIC MAPPING WAS PERFORMED BY:
   WATERWAYS CONSULTING, INC.
   509A SWIFT STREET
   SANTA CRUZ, CA 95060
   SURVEY DATE; NOVEMBER 7–9, 2018
2. LIDAR DATA PROVIDED BY: RESOURCE CONSERVATION DISTRICT OF AMADOR COUNTY
3. ELEVATION DATUM: GPS TIES TO NAVD88 USING THE LEICA GEOSYSTEMS SMARTNET GLOBAL NAVIGATION SATELLITE SYSTEM (GNSS) NETWORK.
4. BASIS OF BEARINGS: GPS TIES TO NAD83 CALIFORNIA STATE PLANE, ZONE 3 USING THE LEICA GEOSYSTEMS SMARTNET GLOBAL NAVIGATION SATELLITE SYSTEM (GNSS) NETWORK.
5. CONTOUR INTERVAL IS FIVE FEET. ELEVATIONS AND DISTANCES SHOWN ARE IN DECIMAL FEET.
6. THIS IS NOT A BOUNDARY SURVEY. PROPERTY LINES ARE NOT SHOWN HEREON.

UPPER ONION SITE CONCEPT ALTERNATIVE #1

SCALE: 1" = 50'

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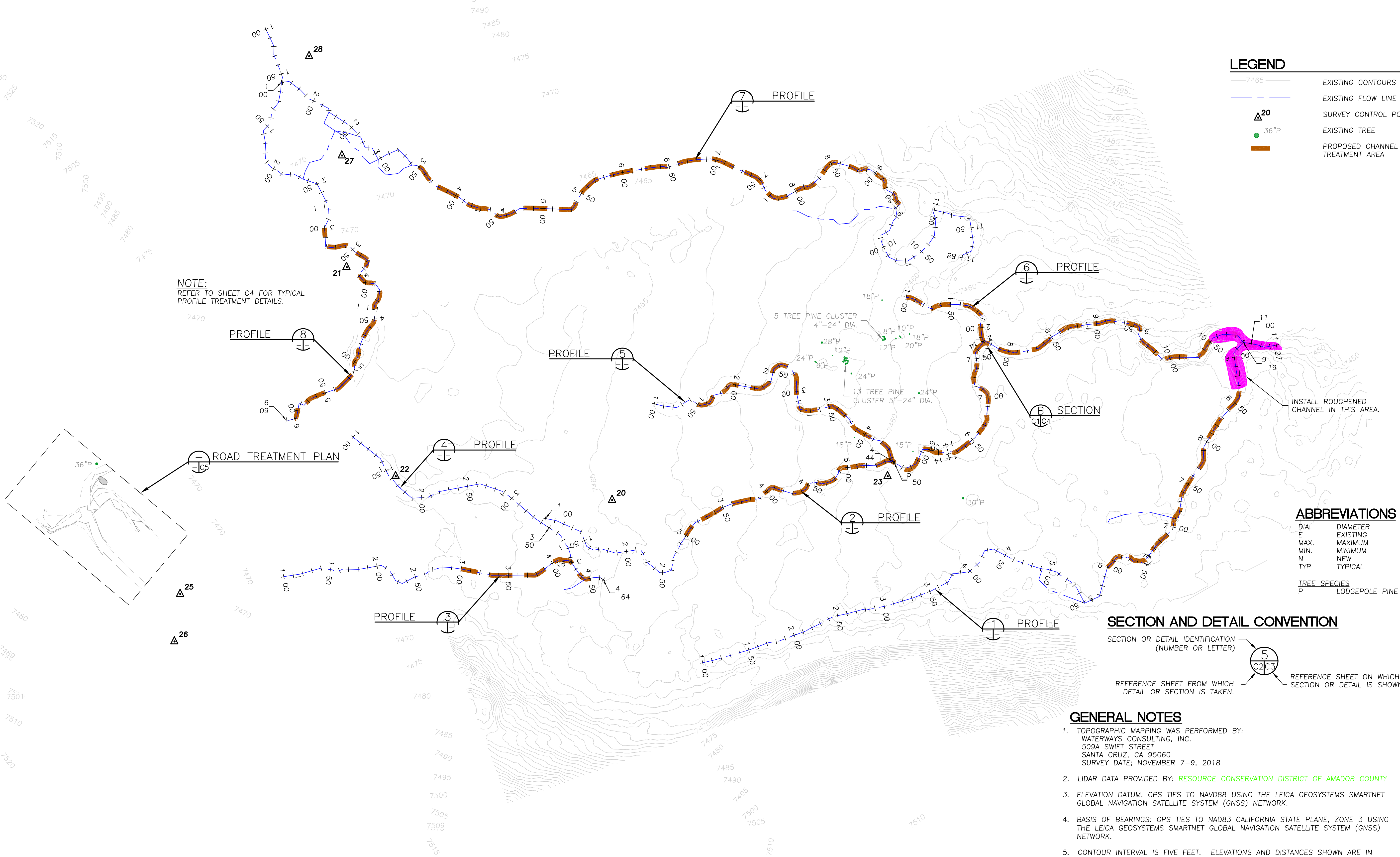
UPPER ONION SITE CONCEPT ALTERNATIVE #1

THREE MEADOWS RESTORATION PROJECT PHASE 1

DESIGNED BY:	–
DRAWN BY:	S.M.R.
CHECKED BY:	M.W.W.
DATE:	01/04/19
JOB NO.:	18–016

BAR IS ONE INCH ON ORIGINAL DRAWING, ADJUST SCALES FOR REDUCED PLOTS
0 1"

SHEET INDEX



LEGEND

7465	EXISTING CONTOURS
	EXISTING FLOW LINE
20	SURVEY CONTROL POINT
36"P	EXISTING TREE
	PROPOSED CHANNEL TREATMENT AREA

ABBREVIATIONS

DIA.	DIAMETER
E	EXISTING
MAX.	MAXIMUM
MIN.	MINIMUM
N	NEW
TYP	TYPICAL

TREE SPECIES

P	LODGEPOLE PINE

SECTION AND DETAIL CONVENTION

SECTION OR DETAIL IDENTIFICATION (NUMBER OR LETTER)

5 C2 C3

REFERENCE SHEET FROM WHICH DETAIL OR SECTION IS TAKEN.

REFERENCE SHEET ON WHICH SECTION OR DETAIL IS SHOWN.

GENERAL NOTES

1. TOPOGRAPHIC MAPPING WAS PERFORMED BY:
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UPPER ONION SITE CONCEPT ALTERNATIVE #2

SCALE: 1" = 50'

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UPPER ONION SITE CONCEPT ALTERNATIVE #2

THREE MEADOWS RESTORATION PROJECT PHASE 1

DESIGNED BY:	–
DRAWN BY:	S.M.R.
CHECKED BY:	M.W.W.
DATE:	01/04/19
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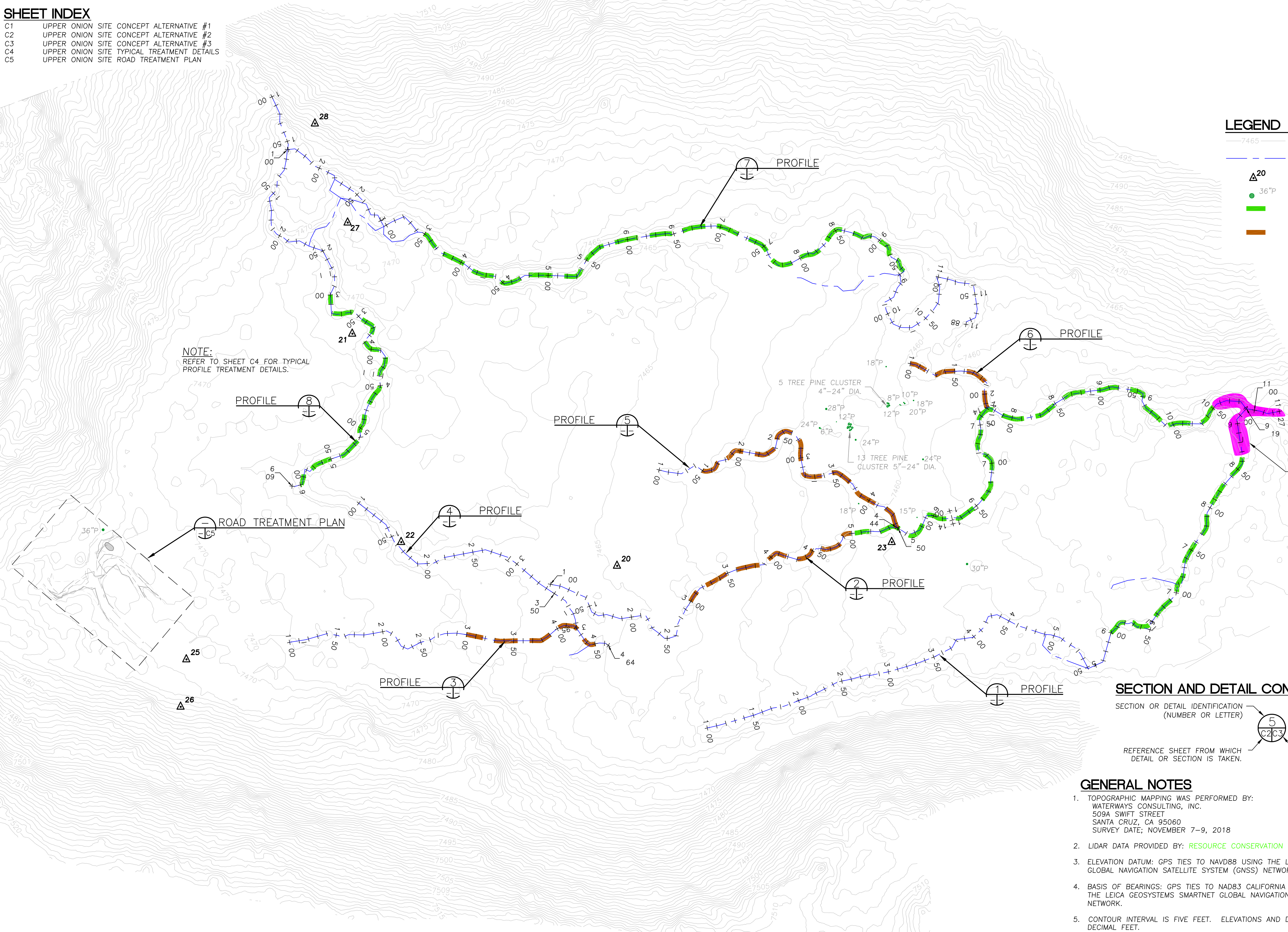
BAR IS ONE INCH ON ORIGINAL DRAWING, ADJUST SCALES FOR REDUCED PLOTS

0 1"

C2

SHEET INDEX



UPPER ONION SITE CONCEPT ALTERNATIVE #3

SCALE: 1" = 50'

LEGEND

7465	EXISTING CONTOURS
	EXISTING FLOW LINE
20	SURVEY CONTROL POINT
36"P	EXISTING TREE
	PROPOSED RIFFLE TREATMENT AREA
	PROPOSED CHANNEL TREATMENT AREA

ABBREVIATIONS

DIA.	DIAMETER
E	EXISTING
MAX.	MAXIMUM
MIN.	MINIMUM
N	NEW
TYP	TYPICAL

TREE SPECIES

P	LODGEPOLE PINE

SECTION AND DETAIL CONVENTION

SECTION OR DETAIL IDENTIFICATION (NUMBER OR LETTER)

5
C2 C3

REFERENCE SHEET FROM WHICH DETAIL OR SECTION IS TAKEN.

REFERENCE SHEET ON WHICH SECTION OR DETAIL IS SHOWN.

GENERAL NOTES

1. TOPOGRAPHIC MAPPING WAS PERFORMED BY:
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   SANTA CRUZ, CA 95060
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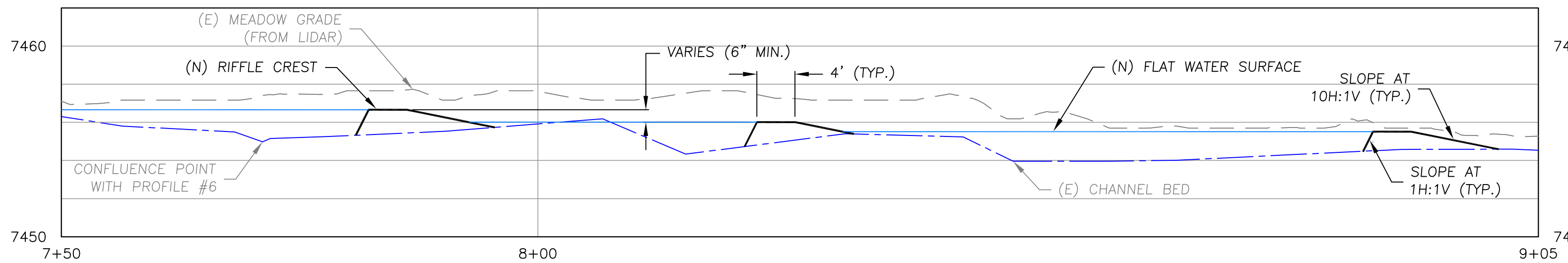
AMADOR RESOURCE CONSERVATION DISTRICT

UPPER ONION SITE CONCEPT ALTERNATIVE #3

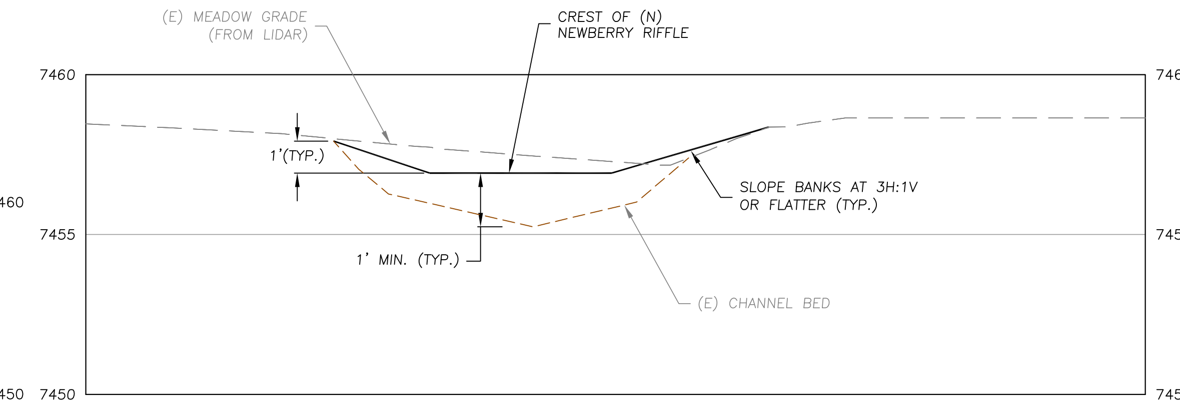
THREE MEADOWS RESTORATION PROJECT PHASE 1

DESIGNED BY:	–
DRAWN BY:	S.M.R.
CHECKED BY:	M.W.W.
DATE:	01/04/19
JOB NO.:	18–016

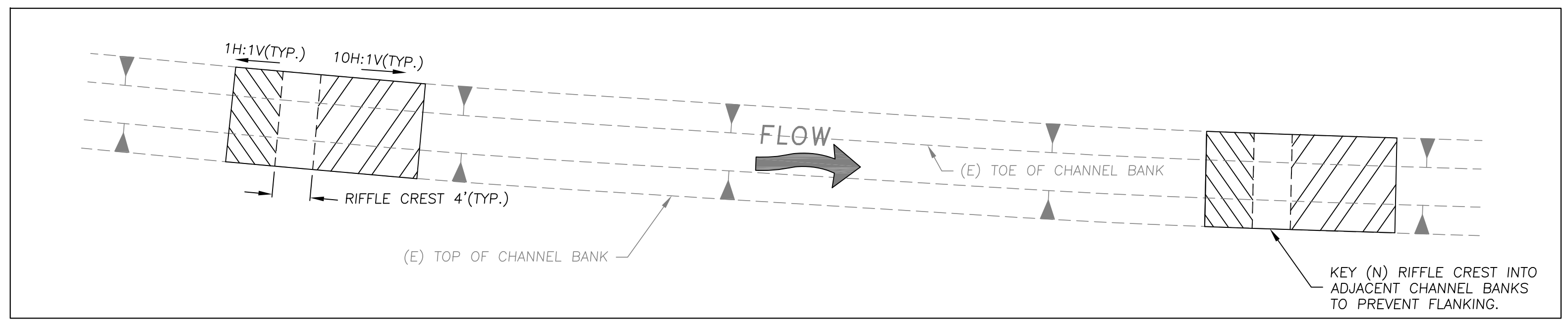
BAR IS ONE INCH ON ORIGINAL DRAWING, ADJUST SCALES FOR REDUCED PLOTS
0 1"



PROFILE 2 STA. 7+50 - 9+00
SCALE: 1" = 10'H ; 1" = 5V

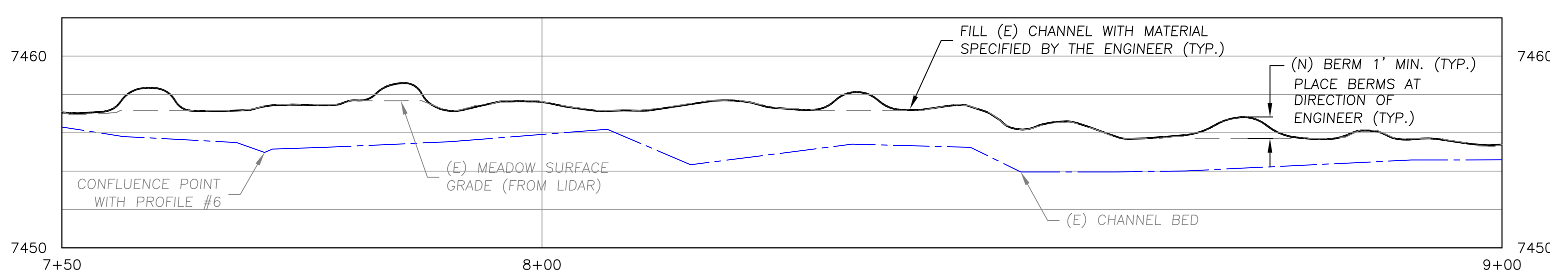


SECTION A C1 C4
SCALE: 1" = 3'

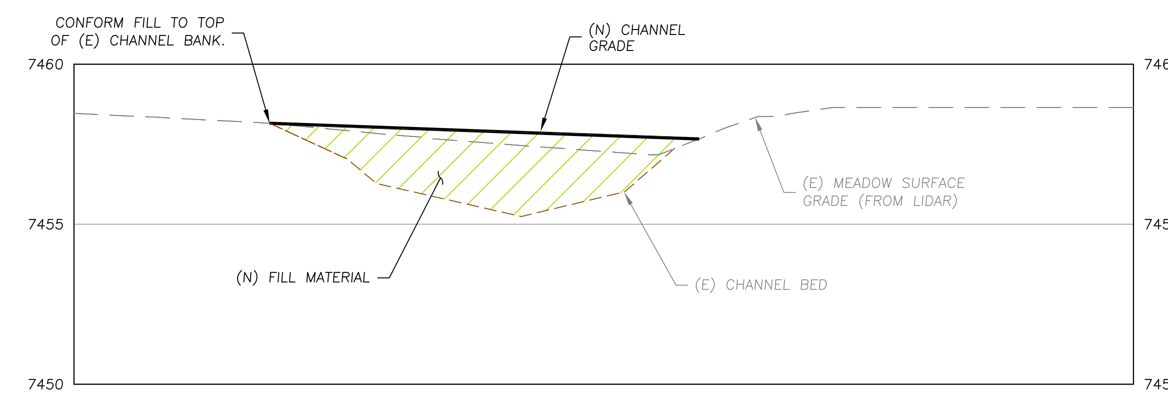


CONCEPT #1 TYPICAL PLAN VIEW
SCALE: 1" = 10'

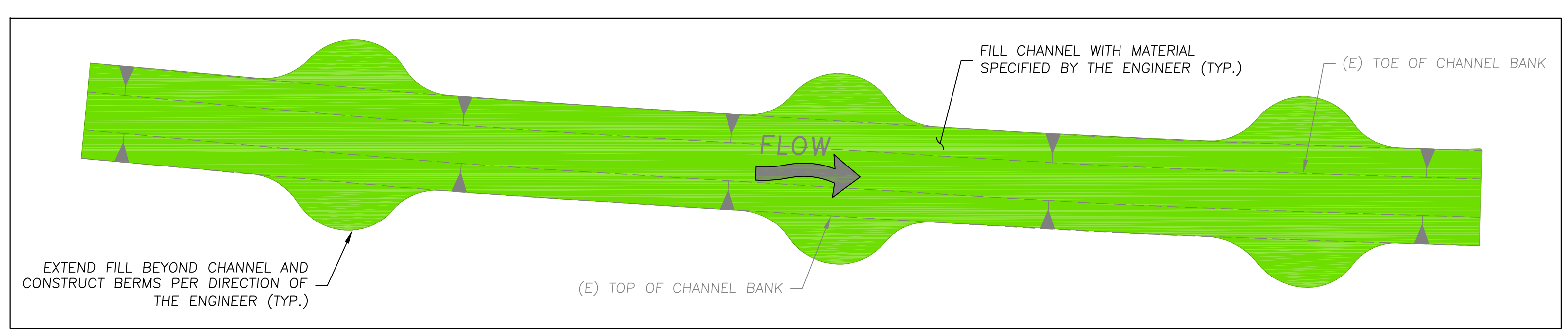
CONCEPT #1 TYPICAL TREATMENT DETAILS



PROFILE 2 STA. 7+50 - 9+00
SCALE: 1" = 10'H ; 1" = 5V



SECTION B C1 C4
SCALE: 1" = 3'



CONCEPT #2 TYPICAL PLAN VIEW
SCALE: 1" = 10'

CONCEPT #2 TYPICAL TREATMENT DETAILS

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PREPARED AT THE REQUEST OF:
AMADOR RESOURCE CONSERVATION DISTRICT

TYPICAL CONCEPT DETAILS UPPER ONION SITE

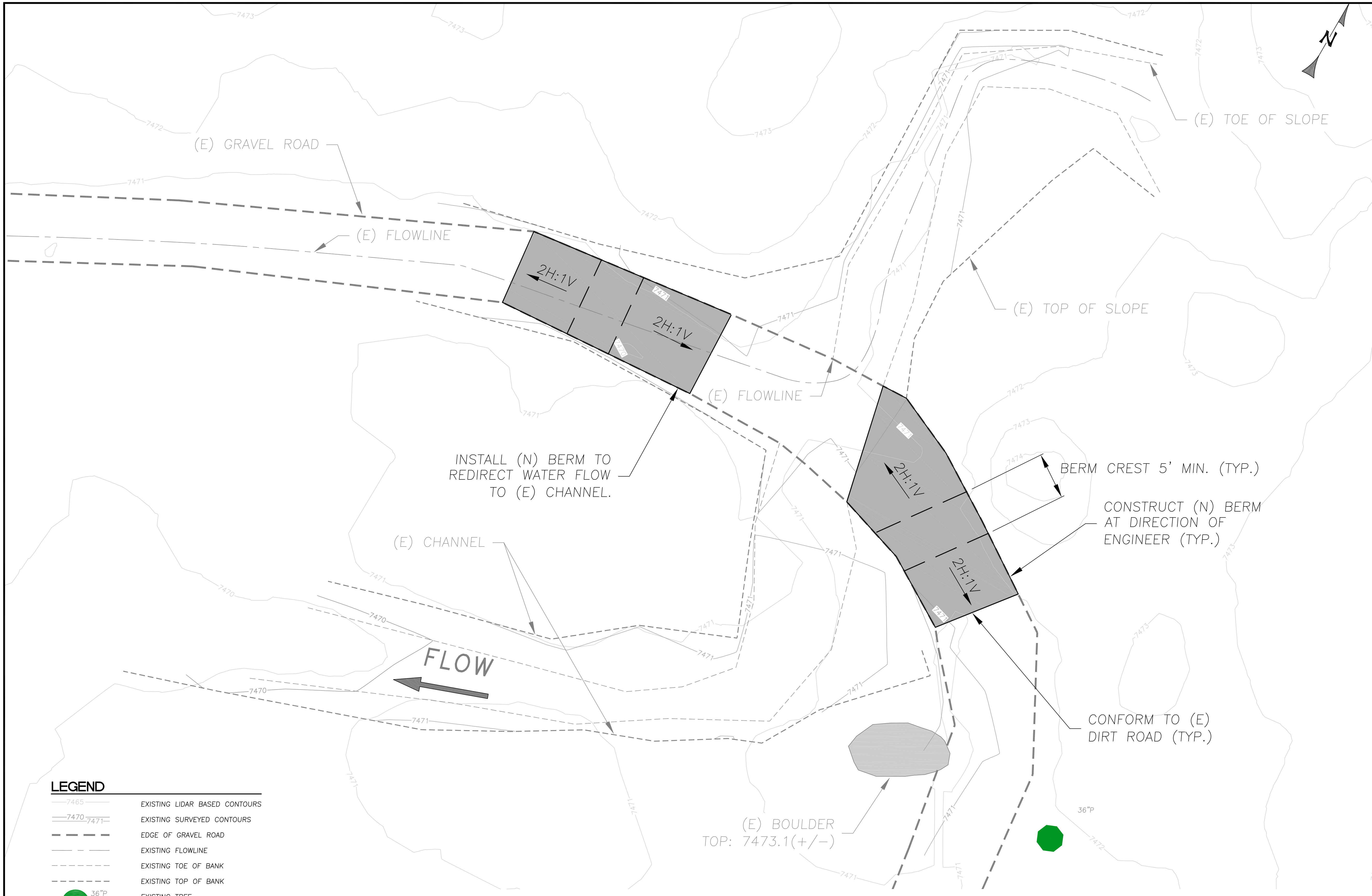
THREE MEADOWS RESTORATION PROJECT PHASE 1

DESIGNED BY: –
DRAWN BY: S.M.R.
CHECKED BY: M.W.W.
DATE: 01/04/19
JOB NO.: 18–016

BAR IS ONE INCH ON ORIGINAL DRAWING, ADJUST SCALES FOR REDUCED PLOTS
0 1"

C4

4 OF 5



ROAD TREATMENT PLAN
SCALE: 1" = 5'

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PREPARED AT THE REQUEST OF:
AMADOR RESOURCE
CONSERVATION DISTRICT

UPPER ONION
SITE CONCEPT
ROAD
TREATMENT
PLAN

THREE MEADOWS
RESTORATION
PROJECT PHASE 1

DESIGNED BY: –
DRAWN BY: S.M.R.
CHECKED BY: M.W.W.
DATE: 01/04/19
JOB NO.: 18–016

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0 1"

C5