City of Ketchum
Planning & Building

STAFF REPORT
KETCHUM PLANNING AND ZONING COMMISSION
REGULAR MEETING OF JANUARY 13, 2020

PROJECT:	Swan Geogrid
FILE NUMBER:	P19-138
PRIOR/ASSOCIATED:	15-144 P17-055 P17-134 P19-044
OWNER:	Robert H. and Sandra Swan
APPLICANT:	Sandra Swan
REQUEST:	Floodplain development application for installation of a geogrid within the floodplain
LOCATION:	401 Northwood Way (Lot 12, Chateaux of Northwood)
ZONING:	General Residential – Low Density (GR-L)
OVERLAY:	Floodplain with Waterways Design Review and Floodway subdistricts
NOTICE:	Notice was published in the Idaho Mountain Express on December 25, 2019 and was mailed to property owners within a 300-foot radius on December 30, 2019.
REVIEWER:	Brittany Skelton, Senior Planner
ATTACHMENTS:	A. Application B. Narrative and plans C. Public comment D. P19-044 E. Criteria for Evaluation of Applications (KMC 17.88.050.E) F. Manufacturers "Design and Installation Guidelines for Erosion Control" manual

BACKGROUND

Sandra and Robert Swan, property owners, have applied for a floodplain development application to install a honey-comb shaped synthetic grid within a portion of 1% annual chance floodplain in order to provide additional protection from erosion during flood events.

The Big Wood River traverses the western boundary of the subject property and a side channel of the river roughly bisects the property in half (south/north). The subject parcel is 188,167 square feet in size (4.3 acres) and contains 100-year floodplain (also known as the Special Flood Hazard Area or 1% annual chance floodplain), floodway, riparian area regulated by Ketchum Municipal Code.

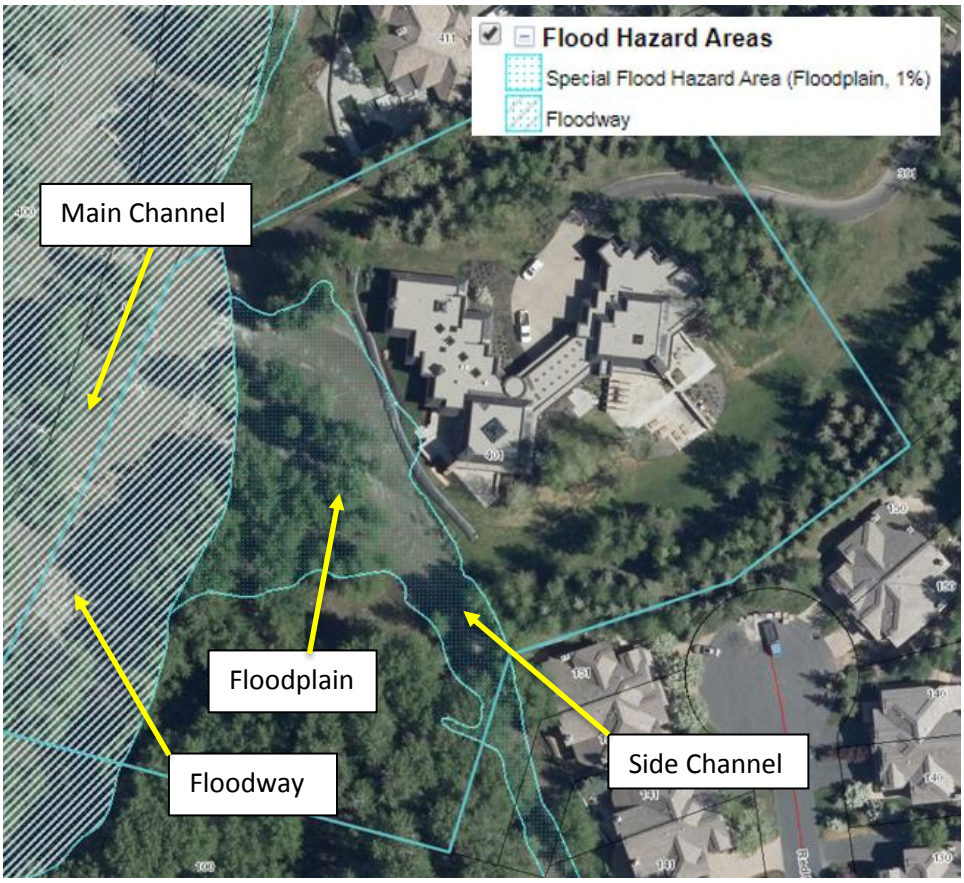


Figure 1.
Aerial photo taken June 2, 2017, during 2017 flood

"Floodway" is a technical term referring to the channel of a river and the adjacent land areas that must be left undeveloped so that a 100-year flood can flow through these areas and obstructions (buildings/structures) will not cumulatively increase the water surface elevation more than one foot (1'). No buildings/structures are permitted to be built in the floodway.

"Floodplain", as used in this staff report, refers to the 100-year floodplain (also known as the 1% annual chance floodplain or Special Flood Hazard Area), and refers to the land area which has been or may be covered by water of a flood of 100-year frequency. Typically, new buildings are permitted to be built in the floodplain provided floodplain construction methodology is used.

"Riparian area/Riparian zone", as used in this staff report and regulated by Ketchum's floodplain ordinance, refers to area along the banks of any waterway twenty-five feet (25') in width measured horizontally from the mean high-water mark. Ketchum's floodplain ordinance regulates the types of vegetation that must be planted

in the 25' riparian zone and prohibits all types of development and land disturbance, other than permitted landscape restoration and streambank stabilization projects.

The Big Wood River's bank breached at the subject property during the 2017 flood. A debris dam also occurred downstream during the flood and the debris dam, accompanied by the deposition of a significant amount of gravel within the river channel, resulted in prolonged (several month) and severe overland flooding on the subject property. The riverbank adjacent to the main channel of the Big Wood partially collapsed upstream of the debris dam and erosion of land area previously characterized as residential lawn occurred during the flood.

The bank of the Big Wood River was also breached at the subject property in 2018 and 2019, despite neither year being a year of widespread or record flooding, and the property experienced overland flooding into the floodplain each year. Engineering surveys and engineering analysis demonstrate that flooding occurred during 2018 and 2019 because significant amounts of gravel were deposited in the channel of the river adjacent to the property. Essentially, the elevation of the bed of the river was raised and the distance between the typical surface height of the water and the surface elevation of the subject property at the streambank was decreased.

Staff has worked with the property owners and their representatives through a series of permits since the 2017, resulting in a 2019 approval (P18-131) for an extensive stream alteration project consisting of dredging/extracting gravel from the stream channel, rebuilding and stabilizing the streambank, rehabilitating the riparian zone, and reclaiming eroded land in the floodplain.

A point of divergence between city staff and the property owners and their consulting team in the P18-131 project proposal was the type and density of vegetation to be installed in the land area located outside of the 25' riparian zone but within the 1% annual chance floodplain. The city, as well as the Idaho Department of Water Resources (IDWR), strongly supported rehabilitating the 1% annual chance floodplain area with deeply-rooted grasses and shrubs, planted in sufficiently dense quantities, as a mechanism to mitigate or prevent erosion in future flood events. When the 2017 flood occurred the groundcover present at the subject property in the 25' riparian zone, as well as the remainder of the floodplain, was largely turfgrass lawn and the proposal was to restore the floodplain area to match pre-flood conditions as closely as possible.

Some of the articulated purposes of Ketchum's floodplain ordinance (KMC 17.88.010) are "to regulate uses in the floodplain for the purpose of preserving, protecting, and enhancing the abundance and diversity of fish, wildlife and riparian resources," "to allow the river and creeks and their adjacent lands to convey floodwaters to minimize property damage" "to restrict or prohibit uses which are injurious to health, safety or property in times of flood, which result in environmental damage, or that cause increased flood heights or velocities," and "to ensure that those who occupy the areas of special flood hazard assume the responsibility for their actions."

Methods for reducing flood losses provided by the floodplain ordinance (KMC 17.88.030) include "Restricting or prohibiting uses which are dangerous to health, safety, and property due to water or erosion hazards, or which result in damaging increases in erosion or flood heights or velocities" and "Controlling the alteration of natural floodplains, stream channels, and natural protective barriers, which help accommodate or channel floodwaters."

Specific evaluation criteria (attachment E) are found in 17.88.050.E with the most relevant being 17.88.050.E.1, "Preservation or restoration of the inherent natural characteristics of the river and creeks and floodplain areas."

The applicant's proposal in P18-131 had included the geogrid, covering an approximately 7,000 square foot area in the floodplain, turfgrass groundcover, a shrub planting density of 3 shrubs per 1,000 square feet, and the planting of 5 cottonwood seedlings, while staff had recommended a minimum shrub planting density of 30% in the floodplain (staff letter dated 12-10-2018). The USDA-NRCS Part 650 Engineering Field Handbook,

Chapter 13, Wetland Restoration, Enhancement, or Creation, p 13-92, recommends a planting density of shrubs on 5 to 8-foot centers in Pacific Northwest riparian woodland areas; IDWR previously estimated this vegetation density to translate to 25 shrubs per 1,000 square feet.

Permit P18-131 was approved with a planting density of 3 shrubs per 1,000 square feet and 5 cottonwood seedlings in the floodplain but without installation of the geogrid.

Because P18-131 was approved without the geogrid, yet the property and their engineer desire additional protection from erosion in the floodplain by a means other than vegetation, the geogrid is before the Commission as a stand-alone application. In accordance with 17.88.050.D.2, staff has forwarded the application to the Commission for a decision, rather than acting on the permit administratively. Staff elected to forward the application to the Commission since geogrids have not been contemplated by the ordinance previously, there are no precedent approvals, and in general the floodplain ordinance supports natural floodplain function.

The request before the Commission is for installation of the geogrid, as specified in the Brockway Engineering memo dated November 14, 2019 and the plan drawings dated November 14, 2019 (attachment B) in a land area approximately 7,023 square feet in size.

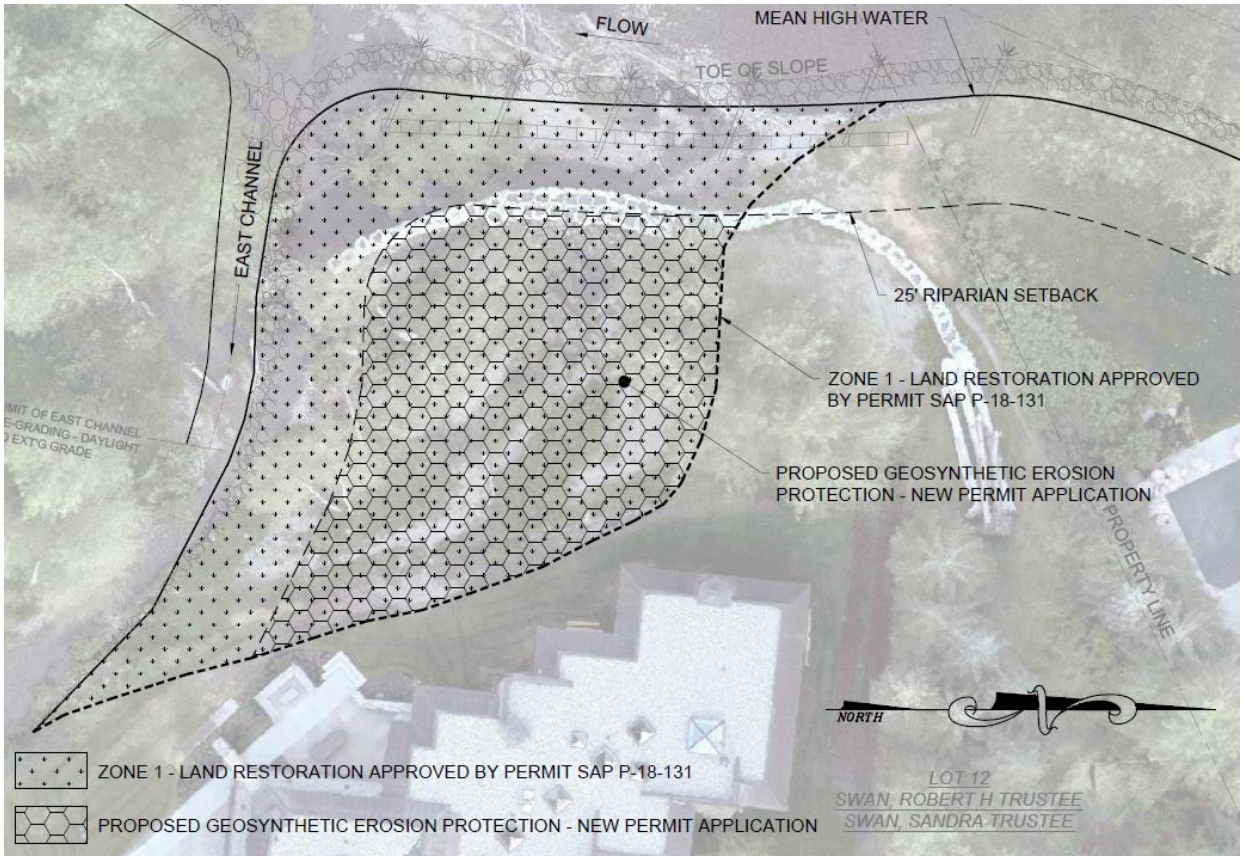


Figure 2. Area of proposed geogrid installation

The Commission may approve the application as submitted, with conditions, or may deny the application.

If the application is denied the approvals granted with P18-131 remain in effect. However, the applicant is not required to plant only the 3 shrubs per 1,000 square feet and the 5 cottonwood seedlings. Staff supports a modification to the proposal to change the groundcover (grass mix) to a riparian grass mix and to increase planting density in order to mitigate the risk of erosion during a future flood event.

STAFF RECOMMENDATION

Staff recommends denial of the application.

Staff recommends deliberation of the application and review of the Findings of Fact, Conclusions of Law, and Decision at the Commission's scheduled February 24, 2020 special meeting.

RECOMMENDED MOTION

"I MOVE to deny the Swan Geogrid Floodplain Development Application."

ATTACHMENTS

A. Application
B. Narrative and plans
C. Public comment
D. P19-044
E. Criteria for Evaluation of Applications (KMC 17.88.050.E)
F. Manufacturers "Design and Installation Guidelines for Erosion Control" manual

A. Application

City of Ketchum
Planning & Building

OFFICIAL USE ONLY
File Number:
Date Received:
By:
Fee Paid:
Approved Date:
Denied Date:
By:

Floodplain Management Overlay Application

OWNER INFORMATION			
Project Name: Swan Bank Protection			
Owner Name: Sandra Swan			
Mailing Address: 8 Brittany Mdws Atherton, CA 94027			
Phone:			
Email:			
PROJECT INFORMATION			
Architect/Representative: Charles G. Brockway P.E.			
Phone: 208-736-8543			
Mailing Address: 2016 Washinton St. N Suite #4 Twin Falls, ID 83301			
Email: charles.g.brockway@brockwayeng.com			
Engineer of Record: Charles G. Brockway			
Engineer Email: charles.g.brockway@brockwayeng.com			
Legal Land Description: T.4N R.17E SEC.12 NW SE			
Project Address: 401 Northwood Way Ketchum, ID`			
Lot Area: 4.3 Acres			
Zoning District: General residential low density			
Anticipated Use:			
Value of Construction: $			
TYPE OF CONSTRUCTION			
☐ New	☐ Remodel	☐ Addition	☐ Other, please explain:
☐ Waterways Design Review	■ Floodplain Development	☐ Stream Alteration	

TOTAL FLOOR AREA			
Proposed		Existing	
Basement:			
1st Floor:			
2nd Floor:			
3rd Floor:			
Decks:			
Mezzanine:			
Total:			
Building Coverage: SF %		Curb Cut: SF %	
PROPOSED SETBACKS			
Front:	Side:	Side:	Rear:
ADDITIONAL INFORMATION			
Building Height:		Parking Spaces Provided:	
Will Fill or Excavation Be Required? ☑ Yes ☐ No			
If Yes, Amount in Cubic Yards	Fill: See attached narrativ	Excavation: See attached narrative	
Will Existing Trees or Vegetation Be Removed? Yes ☐ No ☑			

Applicant agrees in the event of a dispute concerning the interpretation or enforcement of the Floodplain Management Overlay Application, in which the City of Ketchum is the prevailing party, to pay reasonable attorney fees, including attorney fees on appeal, and expenses of the City of Ketchum. I, the undersigned, certify that all information submitted with and upon this application form is true and accurate to the best of my knowledge and belief.

Signature of Owner/Representative — Date: Nov 20, 2019

B. Narrative and plans

Narrative to Address Specific Evaluation Criteria
Floodplain Development Permit Application – Swan Geosynthetic Erosion Protection

1. Preservation or restoration of the inherent natural characteristics of the river and creeks and floodplain areas. Development does not alter river channel.

Proposed work will be subsurface and will not impair the natural characteristics of the floodplain areas.

2. Preservation of riparian vegetation and wildlife habitat, if any, along the stream bank and within the required minimum twenty-five-foot (25') setback or riparian zone. No construction activities, encroachment or other disturbance (mowing, pruning, or any other landscape activity) into the twenty-five-foot (25') riparian zone, except for restoration, shall be allowed at any time without written city approval per the terms of this chapter.

No proposed work within the 25-foot riparian zone.

3. No development, other than development by the city of Ketchum or development required for emergency access, shall occur within the twenty-five foot (25') riparian zone with the exception of approved stream stabilization work. The planning and zoning commission may approve access to property where no other primary access is available. Private pathways and staircases shall not lead into or through the riparian zone unless deemed necessary by the planning and zoning commission.

No proposed work within the 25-foot riparian zone.

4. A landscape plan and time frame shall be provided to restore any vegetation within the twenty-five foot (25') riparian zone that is degraded, not natural or which does not promote bank stability.

No proposed work within the 25-foot riparian zone.

5. New or replacement planting and vegetation shall include plantings that are low growing and have dense root systems for the purpose of stabilizing stream banks and repairing damage previously done to riparian vegetation. Examples of such plantings include: red osier dogwood, common chokecherry, serviceberry, elderberry, river birch, skunk bush sumac, Bebb's willow, Drummond's willow, little wild rose, gooseberry, and honeysuckle.

Vegetation plan has been approved for restored land and riparian zone (SAP P18-131).

6. Landscaping and driveway plans to accommodate the function of the floodplain to allow for sheet flooding. Floodwater carrying capacity is not diminished by the proposal. Surface drainage is controlled and shall not adversely impact adjacent properties including driveways drained away from paved roadways. Culvert(s) under driveways may be required. Landscaping berms shall be designed to not dam or otherwise obstruct floodwaters or divert same onto roads or other public pathways.

Floodplain function will not be impaired. Proposed work will be subsurface.

7. Impacts of the development on aquatic life, recreation, or water quality upstream, downstream or across the stream are not adverse.

Proposed work will be subsurface and will not impact aquatic life, recreation, or water quality.

8. Building setback in excess of the minimum required along waterways is encouraged. An additional ten foot (10') building setback is encouraged to provide for yards, decks and patios outside the twenty-five foot (25') riparian zone.

Not applicable.

9. The top of the lowest floor of a building located in the one percent (1%) annual chance floodplain shall be a minimum of twenty-four inches (24") above the base flood elevation of the subject property.

Not applicable.

10. The backfill used around the foundation in the floodplain shall provide a reasonable transition to existing grade but shall not be used to fill the parcel to any greater extent. Compensatory storage shall be required for any fill placed within the floodplain. An LOMA-F shall be obtained prior to placement of any additional fill in the floodplain.

Not applicable.

11. All new buildings shall be constructed on foundations that are approved by a licensed professional engineer.

Not applicable.

12. Driveways shall comply with effective street standards; access for emergency vehicles has been adequately provided for.

Not applicable.

13. Landscaping or revegetation shall conceal cuts and fills required for driveways and other elements of the development.

Not applicable.

14. (Stream Alteration Only.) The proposal is shown to be a permanent solution and creates a stable situation.

Not applicable.

15. (Stream Alteration Only.) No increase to the one percent (1%) annual chance floodplain upstream or downstream has been certified, with supporting calculations, by a registered Idaho hydraulic engineer.

Not applicable.

16. (Stream Alteration Only.) The recreational use of the stream, including access along any and all public pedestrian/fisher's easements, and the aesthetic beauty shall not be obstructed or interfered with by the proposed work.

Not applicable.

17. Where development is proposed that impacts any wetland, first priority shall be to move development from the wetland area. Mitigation strategies shall be proposed at time of application that replace the impacted wetland area with a comparable amount and/or quality of new wetland area or riparian habitat improvement.

Not applicable.

18. (Stream Alteration Only.) Fish habitat shall be maintained or improved as a result of the work proposed.

Not applicable.

19. (Stream Alteration Only.) The proposed work shall not be in conflict with the local public interest, including but not limited to, property values, fish and wildlife habitat, aquatic life, recreation and access to public lands and waters, aesthetic beauty of the stream and water quality.

Not applicable.

20. (Stream Alteration Only.) The work proposed is for the protection of the public health, safety and/or welfare such as public schools, sewage treatment plant, water and sewer distribution lines and bridges providing particularly limited or sole access to areas of habitation.

See attached narrative for additional details. This application seeks only to add the geosynthetic erosion control product to protect the restoration of eroded land. All other aspects of the project have been evaluated and approved in SAP P18-131.

Swan Property Restoration Plan: Stream Alteration and Floodplain Development Permit Application for Erosion Protection of Restored Land

Charles G. Brockway, Ph.D., P.E.
Brockway Engineering, PLLC

November 14, 2019

A. Background

In the recently-approved City of Ketchum Stream Alteration Permit SAP P18-131, restoration and revegetation of eroded land on the floodplain was approved. However, erosion protection of the restored land using a geosynthetic material was removed from the application at the City of Ketchum's request so that it could be considered as a separate application. This change was necessary to obtain an administrative approval of SAP P18-131, and was not desired by the applicant nor recommended by the project engineer. The prior project approval now warrants a second SAP application for erosion control measures on the property.

Newly-placed soil associated with restoration of eroded land within Zone 1 under the approved SAP P18-131 must be protected from erosion so that it does not wash away during sheet flooding, as it did during 2017 and to a lesser extent during 2018 and 2019. This revised narrative and associated Floodplain Development Permit Application pertains to this activity only. This activity has already been approved by the U.S. Army Corps of Engineers (USACE) and the Idaho Department of Water Resources (IDWR).

Previously-issued permits include the following:

1. Removal of a large debris dam which had formed during the flood of 2017. The dam had raised water levels, caused major gravel deposition in the main river channel, and caused water to leave its banks and cut eastward through the applicant's yard. This dam was the primary source of the flooding problems on the subject property and its removal was the first step toward a long-term solution.

2. Emergency work in May 2018 to place 1-yard gravel bags across the breach area. Even though runoff magnitude in 2018 was moderate (a peak flow of only 836 cfs), water overtopped the bank and cut eastward and the bags were placed to prevent further property damage. At this flow, there would have been zero floodplain inundation but for the gravel deposition in the river channel.

3. Approval of City of Ketchum SAP P18-131 for a multi-faceted stream bank stabilization and land restoration effort, absent the geosynthetic erosion protection component (at the request of the City of Ketchum).

The proposed installation of geosynthetic erosion protection is described below and is illustrated on the accompanying drawings.

B. Proposed erosion protection on restored land

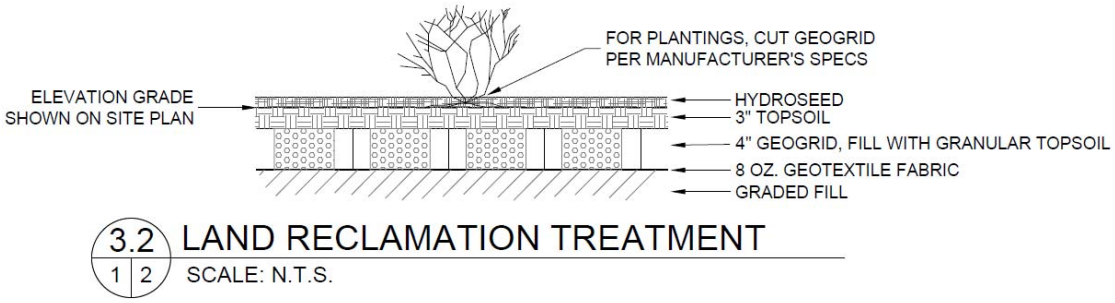
City permit SAP P18-131 allowed restore eroded turf and riparian areas to substantially pre-2017 extents and grade, i.e. prior to the discrete flood event of 2017. This area must still be allowed to function as a flood plain, and therefore it is important to ensure that the restored area can withstand shallow sheet flow without succumbing to the erosion seen in 2017 and 2018. Previous HEC-RAS modeling indicates that during the 100-year event as much as 232 cfs (8% of the total streamflow) will flow in the east floodplain at velocities from 1.4 to 2.0 ft/s. To accomplish the erosion protection, a subsurface honeycomb-type soil stabilization product is proposed within the restoration area, but not within the 25-foot riparian setback as per an IDWR requirement.

The term "geogrid" is a generic term applied to a wide variety of semi-rigid sheet goods utilized for stabilization of soils and protection against erosion. The product proposed for the Swan project is the Envirogrid EGA40. This product has a honeycomb configuration with a height of 4 inches and a cell size of 8 inches. The cells of the honeycomb are filled with granular soil and in this case the product will be topped with topsoil. Once installed it will not be invisible and is no different from an aesthetic standpoint than other permanent infrastructure routinely installed underground in the City.

This type of product is widely used for soil stabilization, slope erosion control, channel lining, retaining walls, or other protective functions. In the Swan application, the function is slope erosion control. The vegetative treatment approved in SAP P18-131 is the first line of defense and likely can handle most runoff occurrences, but in the event the erosive forces exceed the capacity of the vegetative treatment, the geogrid product will prevent down cutting from occurring below the top of the geogrid layer which, based on evidence from 2017 and 2018, would result in a large portion of the river being captured and directed eastward. Given the owner's desire to implement very strong measures against this risk, some type of permanent erosion protection is warranted. If erosion does occur, it would be limited to the very top layer of soil and very easy to repair without significant disturbance to the flood plain.

The Envirogrid products are often used on slopes much steeper than the area proposed to be treated in the Swan case. The manufacturer of the product was consulted and recommended a medium-duty product that has proven to be effective in this environment, based on land slope and anticipated flow velocities. The photos below illustrate use of this type of product in a riparian setting and show a close up of the perforations in the grid that allow lateral migration of water and soil components. Note that the photos depict an 8" tall product, not the 4" tall product for the Swan project. Again, in the finished state the product will be buried below finished grade.

The schematic below shows the Envirogrid product installation. The product is placed on a graded sub-base and separated from the sub-base by a geotextile fabric. This fabric is similar to a weed mat, but thicker. Separation between the sub-base is needed to prevent mixing of the native material and granular fill material within the cells and potentially destabilizing the base. The Envirogrid is then filled with granular material comprised of sandy loam or gravelly sandy loam, followed by a layer of topsoil. Vegetative treatments within the Zone 1 restoration area have already been approved in SAP P18-131 and consist of grasses as well as riparian shrub plantings. Shrub plantings are made within each cell of the Envirogrid, or if necessary the cell walls can be cut to allow larger plant to be made.



Many alternatives to the geogrid product were considered and discussed with the owner. As with any design, many factors must be balanced. Factors to be considered include the observed potential for erosion and down-cutting of the overbank, the need to protect the residence (which was approved by the City of Ketchum), the need to prevent large-scale flows into the East Channel which would adversely affect numerous residents including the City of Ketchum, and the need to preserve and protect the open space which has been enjoyed by the owner and also approved by the City.

Vegetative treatments alone were deemed important and beneficial but insufficient given the river's demonstrated propensity to forcefully migrate eastward. One other solution would be a buried blanket of rock, covered by topsoil and vegetated. This was deemed too intrusive and undesirable. The geogrid product was selected as the best compromise.

C. Concerns with the geogrid product

City staff has expressed some concerns regarding the efficacy of the geogrid, each of which is addressed as follows.

The geogrid may be an impediment to movement of water and/or biological organisms through the soil. The material comprising the honeycomb is perforated and does not prevent the movement of water, roots, or organisms.

The geogrid may dislodge and end up in the river. The product is a continuous blanket, filled with granular material and topped with soil. It is not possible for water to erode below the top of the geogrid. Installation of the product includes staking it into the ground. Vegetation will be planted in and amongst the cells, providing a root structure to act as a further anchor to the product. The product does not float. For the product to end up in the river, all of these structural measures would have to overpowered, and the river would have to slide the entire layer of geogrid as a unit into the river. Even if such sliding were to occur, it would not be toward the river because there is no gradient in that direction, either topographically or hydraulically.

The product is artificial. This is true. However, any number of man-made items are routinely allowed in floodplains in the City of Ketchum and Blaine County. Examples include concrete foundations, utility vaults and equipment, bridges, driveways, highways, paths, fences, sewer outfalls, ponds, headgates, ski lifts, swimming pools, etc. The important thing is not that the feature is "artificial," but that it is properly protected against flood damage.

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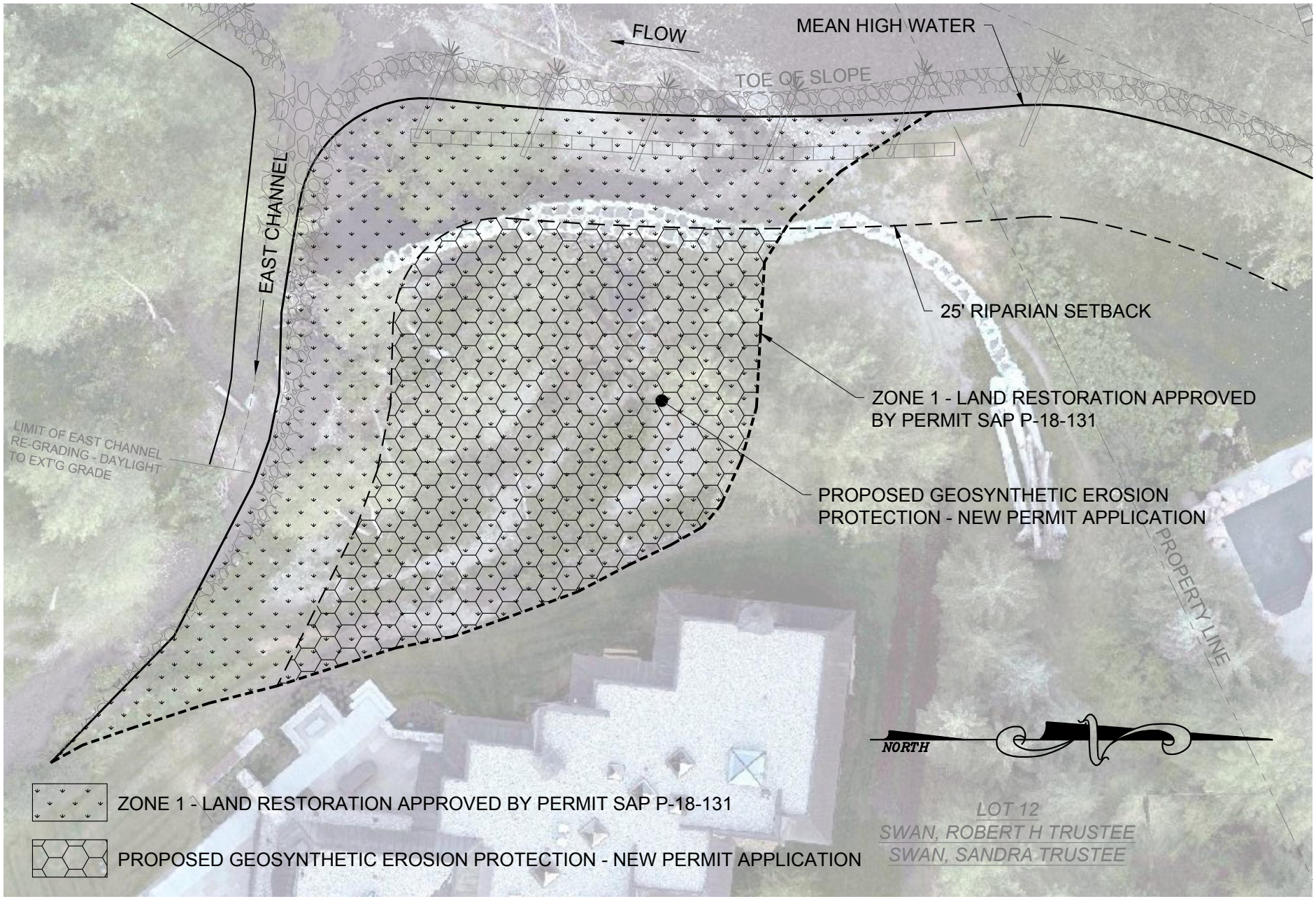

1" = 30' (SCALES FOR 8.5 X11 DWGS ONLY)

REV	DESCRIPTION	DATE	APPRO. BY
A	ISSUE FOR PERMIT	11/14/19	

DESIGNED BY: CGB

DRAFTED BY: ICB

BROCKWAY ENGINEERING, PLLC
HYDRAULICS - HYDROLOGY - WATER RESOURCES
2016 NORTH WASHINGTON, SUITE 4
TWIN FALLS, ID 83301
(208) 736-8543

SWAN, SANDRA
EROSION PROTECTION PERMIT APPLICATION

PLAN

PROJECT # 1436-02-2018

DWG # 1

REV A

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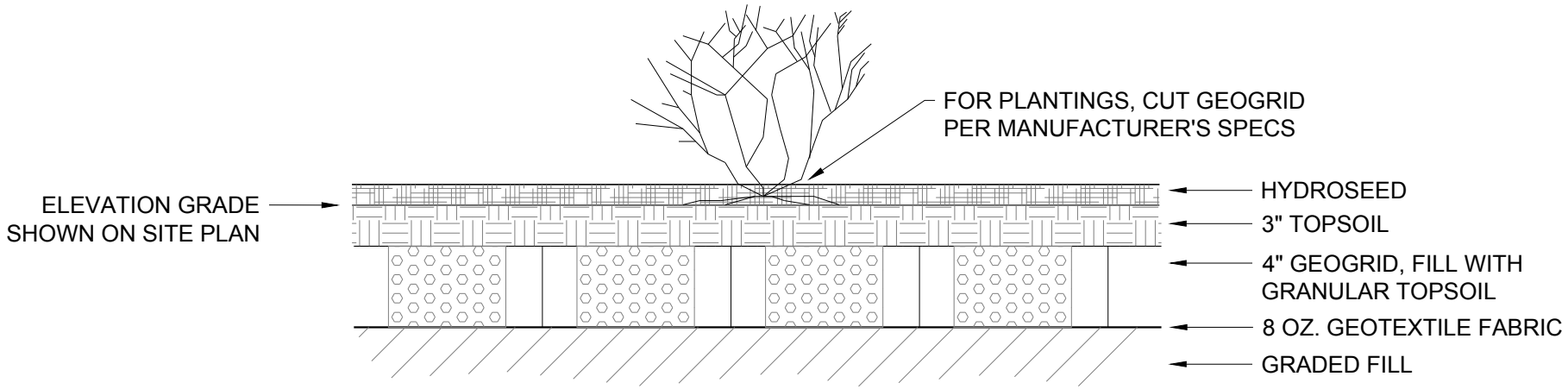


2 LAND RESTORATION TREATMENT

2 - 2 SCALE: N.T.S.

1" = 30' (SCALES FOR 8.5 X11 DWGS ONLY)

REV	DESCRIPTION	DATE	APPRO. BY
A	ISSUE FOR PERMIT	11/14/19	

DESIGNED BY: CGB

DRAFTED BY: ICB

BROCKWAY ENGINEERING, PLLC
HYDRAULICS - HYDROLOGY - WATER RESOURCES
2016 NORTH WASHINGTON, SUITE 4
TWIN FALLS, ID 83301
(208) 736-8543

SWAN, SANDRA
EROSION PROTECTION PERMIT APPLICATION

LAND RESTORATION TREATMENT

PROJECT # 1436-02-2018

DWG # 2

REV A

C. Public comment

Brittany Skelton

From: Participate
Sent: Friday, January 10, 2020 9:06 AM
To: AllPlanningAndZoning
Cc: Robin Crotty
Subject: FW: Swan Geogrid Floodplain Development

Please see public comment below.

LISA ENOURATO | CITY OF KETCHUM
Assistant City Administrator
P.O. Box 2315 | 480 East Ave. N. | Ketchum, ID 83340
o: 208.726.7803 | f: 208.726.7812
lenourato@ketchumidaho.org | www.ketchumidaho.org

From: Barbara Patton <1barbarapatton@gmail.com>
Sent: Thursday, January 09, 2020 7:31 PM
To: Participate <participate@ketchumidaho.org>
Subject: Swan Geogrid Floodplain Development

To whom it may concern:

We are writing in support of the Swan plan to ameliorate the encroachment of the Wood River on their property and also to protect those of us who own property downstream. The process has been exceedingly slow and laborious as well as unduly frustrating for all of us. The time has come for all concerned bureaucracies to realize that by procrastinating their stance on this issue is simply unreasonable and unjust.

Please swiftly conclude passage of their application.

Thank you,

Barbara and Scott Patton

Ketchum Planning and Zoning Commission
480 East Ave. N.
Ketchum, ID 83340

WOOD RIVER LAND TRUST

January 10, 2019

Dear Planning and Zoning Commission,

Regarding: Swan Floodplain Management Overlay Application

We appreciate the opportunity to review and comment on the Swan Floodplain Management Overlay project located at 401 Northwood Way. The Land Trust feels it's important to continue to work with landowners and consultants on projects to find a compromise of flood protection and enhancing natural river function within the Big Wood River.

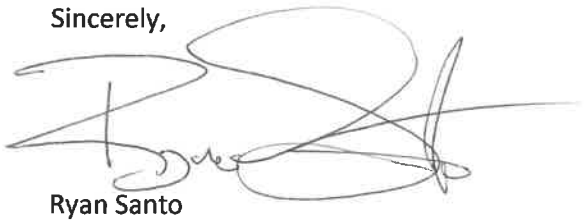
Muncipalities are in a tough position when reviewing these applications; allowing treatments that provide protection of infrastructure but also considering the impacts of those treatments on river health. Residents of the valley believe that protecting the health of the Big Wood River is important and should be preserved and enhance to greatest extent possible.

The applicant proposes to install Envirogrid EGA 40 to stabilize soils and protect against erosion. Reviewing this product I found no examples of this applied to stabilize soils within the floodplain and it's my understanding that this product has not been used in other floodplain management overlay applications. What we have seen work in the Big Wood River floodplain is having native riparian plants with low growing root systems. Establishing these plant communities benefit pollinators and wildlife while stabilizing soils and reduce erosion.

The Biota 2016 Geomorphic Assessment of the Big Wood River found that 52% of floodplain habitat is disconnected from the river. Approving products like the Envirogrid EGA 40 could set precedent for future application to use this product and decrease riparian and floodplain habitat which detrimentally affect wildlife. We would not recommend the use of the Envirogrid EGA 40 to replace what native riparian plants are known to do- stabilizing soils while providing wildlife habitat.

Thank you for your time and consideration.

Sincerely,



Ryan Santo
Wood River Land Trust
Project Coordinator

D. P18-131

City of Ketchum
Planning & Building

IN RE:	)	
	)	
Swan Stream Alteration/Bank Stabilization	)	**KETCHUM PLANNING AND BUILDING DEPARTMENT**
Floodplain Development and Waterways	)	**FINDINGS OF FACT, CONCLUSIONS OF LAW, AND**
Design Review Permit	)	**DECISION**
Date: October 11, 2019	)	
	)	
File Number: P18-131	)	

PROJECT: Swan Stream Alteration/Bank Stabilization

ADFP#: P18-131

OWNER: Robert and Sandra Swan (401 Northwood Way)

Marsupial Properties LLC, Alison and Geoffrey Rusack (411 Northwood Way)

City of Ketchum (Ketchum FR NWSE TL 7801 SEC 12 4N 17E River Bed)

APPLICANT: Robert and Sandra Swan

REPRESENTATIVE: Chuck Brockway, Brockway Engineering PLLC and Evan Robertson, Robertson & Slette PLLC for Robert and Sandra Swan

LOCATION: 401 Northwood Way (Lot 12, Chateaux of Northwood)

411 Northwood Way (Lot 1, Resub of Northwood PUD Lot 2)

Adjacent riverbed (Ketchum FR NWSE TL 7801 SEC 12 4N 17E River Bed)

ZONING: General Residential – Low Density (GR-L) and Floodplain Management Overlay (FP), Waterways and Floodway subdistricts

REQUEST: Stream alteration, bank stabilization, land reclamation and restoration

PRIOR/ASSOCIATED: 401 Northwood Way

- **15-144**
- **P17-055**
- **P17-134**
- **P19-044**

411 Northwood Way

- **P19-047**

BACKGROUND FACTS

1. The City of Ketchum is a municipal corporation organized under Article XII of the Idaho Constitution and the laws of the State of Idaho, Title 50, Idaho Code. Under Chapter 65, Title 67 of the Idaho Code, the City is required to pass certain ordinances regarding land use, including a zoning ordinance.

2. Pursuant to Zoning Code Title 17, Section 17.88.050(D)1, the administrator shall have the authority to consider and approve, approve with conditions, or deny applications for floodplain development permits and for waterways design review.

3. The subject properties contain floodway, stream channel and bank, and riparian area. The proposed scope of work is to occur on three (3) separate parcels, held by three separate owners, with the bulk of the work occurring on 401 Northwood Way. The proposed scope of work is interrelated, with the overall project design dependent on completion of all components of the project. As such, the proposal is being reviewed and approved as a comprehensive, integrated project with the understanding all project components will be completed.

4. The applicant is put on notice that city review and approval of this application does not guarantee that flooding will not occur as the subject property is located in the Special Flood Hazard Area (1% annual chance floodplain, also known as the 100-year floodplain).

5. The scope of work approved by this permit involves excavation from the river channel, bank stabilization along the main channel and eastern side channel, land reclamation, and restoration.

FINDINGS OF FACT

Floodplain Design Review Requirements				
1. EVALUATION STANDARDS: 17.88.050(E)				
Compliant			**Standards and Staff Comments**	
Yes	**No**	**N/A**	**Guideline**	**City Standards and *Staff Comments***
☒	☐	☐	**17.88.050(E)1 FLOODPLAIN DEVELOPMENT/ WATERWAYS DESIGN REVIEW**	**Preservation or restoration of the inherent natural characteristics of the river and creeks and floodplain areas. Development does not alter river channel.**
			Staff Comments	*Prior to the 2017 flood event the area east of the eastern bank of the main channel of the Big Wood River now proposed for bank stabilization and land reclamation/restoration was largely in a manicured, non-native state. Groundcover was largely turfgrass with minimal shrubs and trees. Turfgrass extended to the bank of the river on the bank that abuts the main channel of the Big Wood River.* *The majority of work associated with this permit is proposed to occur on 401 Northwood Way and this parcel contains river channel, floodway (both within and landward to of the channel), and a significant amount of 1% annual chance floodplain. Minor, yet integral to the overall scope of the project, amounts of work are proposed on 411 Northwood Way (riverbed gravel removal, bank stabilization and associated willow plantings) and the parcel owned by the City of Ketchum (riverbed gravel removal, tree and woody debris removal).*

				The project area at 411 Northwood Way contains river channel and a minor amount of floodway (largely aligning with the river channel). The project area on the City of Ketchum parcel contains river channel and is entirely within the floodway. *As described in the narrative and plans submitted by Brockway Engineering, the 2017 flood event resulted in deposition of significant quantities of gravel within the main channel of the Big Wood River in the vicinity of the subject parcels and erosion/land loss due to bank erosion. Subsequent runoff occurred in the spring of 2018 and 2019 with overland flooding both years. Emergency permits were issued for 401 Northwood Way in 2018 and 2019, allowing placement of large grain-feed sacks filled with gravel ("supersack" sandbags), in order to prevent migration of the main channel of the Big Wood River further eastward onto 401 Northwood Way. A tree removal permit was approved for 411 Northwood Way for at-risk trees; the trees have not yet been removed.* *The scope of work approved by this permit involves excavation from the river channel, bank stabilization along the main channel and eastern side channel, land reclamation, and restoration.* *Alteration of the river channel is a permitted action through an approved streambank stabilization project (KMC 17.88.060(E)3).* *Both the 401 Northwood Way and 411 Northwood Way edge-of-banks (east banks of Big Wood River) and the north bank of the side channel on 401 Northwood Way will be stabilized with bank hardening techniques (riprap) and bioengineering techniques (installation of logs with root wads to function as bank barbs, installation of willows within the interspatial voids of the riprap). 401 Northwood Way's land east of the eastern bank will be further protected with the installation of a buried rock sill and the mouth of the eastern side channel is to be protected from widening by installation of buried angular stones.* *In terms of restoration, post-2017 flooding and 2018 and 2019 runoff, land areas on 401 Northwood Way affected by sheet flow are being reclaimed by native, riparian vegetation. If left unaltered by human intervention, a healthy riparian area would likely reestablish naturally.* *However, because the scope of this project at 401 Northwood Way includes land reclamation, bank stabilization, a well as the burying of a rock wall, all existing vegetation will be removed, the land regraded to spot elevations shown in the plan set, and new grasses and shrubs will be installed. As such, the 25' riparian zone on 401 Northwood Way will be restored to a state that is more characteristic of a native riparian zone than what existed prior to the 2017 flood; 401 Northwood Way was first developed with a residence after the city's adoption of riparian standards and riparian zone requirements therefore apply.*

				411 Northwood Way will not have its riparian zone restored (although staff recommends restoration due to the bank-stabilizing and ecosystem health functions such vegetation provides) because the property was first developed with a residence prior to the city's adoption of riparian standards. *On the city parcel several leaner trees and one discrete area of accumulated woody debris is proposed for removal. As actions on the city's parcel are subject to City Council approval through an Encroachment Agreement, this permit notes approval of trees and accumulated woody debris on the city's parcel is subject to a decision by Ketchum City Council.*
☒	☐	☐	**17.88.050(E)2**	**Preservation or enhancement of riparian vegetation and wildlife habitat, if any, along the stream bank and within the required minimum twenty five foot (25') setback or riparian zone. No construction activities, encroachment or other disturbance into the twenty five foot (25') riparian zone, including encroachment of below grade structures, shall be allowed at any time without written City approval per the terms of this chapter.**
			Staff Comments	*Disturbance to the 25' riparian zone is limited to the plans approved through this permit. Any amendment to the proposed scope of work shall be approved in writing as an amendment to this permit.* *See 17.88.060(E)1 for discussion of riparian vegetation.* *Accumulated woody debris and riparian plantings have benefits for aquatic life and the overall riparian ecosystem. Staff does not routinely recommend approval of removal of in-stream wood or woody debris accumulated adjacent to streambanks and in floodplain areas. However, the applicant proposes removal of some, but not all woody debris in order to accomplish the project goals; the applicant also states that much of the woody debris will be reused within the project.*
☒	☐	☐	**17.88.50(E)3**	**No development, other than development by the City of Ketchum or development required for emergency access, shall occur within the twenty five foot (25') riparian zone with the exception of approved stream stabilization work. The Administrator may approve access to property where no other primary access is available. Private pathways and staircases shall not lead into or through the riparian zone unless deemed necessary by the Administrator.**
			Staff Comments	*Currently, no pathways and staircases lead into or through the riparian zone. None are proposed.* *Development activity approved to occur within the riparian zone is described in the plan set attached hereto, as conditioned.*
☐	☐	☒	**17.88.050(E)4**	**A landscape plan and time frame shall be provided to restore any vegetation within the twenty five foot (25') riparian zone that is degraded, not natural or which does not promote bank stability.**
			Staff Comments	*A riparian vegetation restoration plan has been proposed with this project. See Brockway Engineering plan set and BYLA plan.*
☐	☐	☒	**17.88.050(E)5**	**New or replacement planting and vegetation shall include plantings that are low growing and have dense root systems for the purpose of stabilizing stream banks and repairing damage previously done to riparian vegetation. Examples of such plantings include: red osier dogwood, common chokecherry, serviceberry, elderberry, river birch, skunk bush sumac, Beb's willow, Drummond's willow, little wild rose, gooseberry, and honeysuckle.**

			Staff Comments	*A riparian planting restoration plan has been proposed (BYLA) and includes golden currants, red-osier dogwoods, river alder and woods rose in the riparian zone.* *The proposed grasses are per the seed mix identified in the September 30, 2019 Brockway Engineering plan: Idaho fescue, streambank wheatgrass, creeping red fescue, bluebunch wheatgrass and silky lupine.*

Compliant			**Standards and Staff Comments**	
Yes	**No**	**N/A**	**Guideline**	**City Standards and *Staff Comments***
☒	☐	☐	**17.88.050(E)6**	**Landscaping and driveway plans to accommodate the function of the floodplain to allow for sheet flooding. Floodwater carrying capacity is not diminished by the proposal. Surface drainage is controlled and shall not adversely impact adjacent properties including driveways drained away from paved roadways. Culvert(s) under driveways may be required. Landscaping berms shall be designed to not dam or otherwise obstruct floodwaters or divert same onto roads or other public pathways.**
			Staff Comments	*The project has been designed (channel geometry design, stabilized bank elevations, and reclaimed land finished elevations) to allow sheet flooding.* *However, staff finds greater densities of plantings than what are proposed, within both the riparian zone and the remainder of the Special Flood Hazard Area at 401 Northwood Way, are recommended and would result in better control of surface drainage (sheet flow would be slowed down due to the roughness provided by dense vegetation) and would have the added benefits of erosion mitigation and habitat benefit.* *No culverts or berms are proposed.*
☒	☐	☐	**17.88.050(E)7**	**Impacts of the development on aquatic life, recreation, or water quality upstream, downstream or across the stream are not adverse.**
			Staff Comments	*The proposal is designed to balance the goals of protecting land area from erosion, preventing migration of the main channel of the Big Wood River to the east (closer to structures), and protecting private property owners' (401 and 411 Northwood Way) views of the river and enjoyment of their outdoor properties with the characteristics of an unaltered floodplain and riparian area.* *The proposed riparian zone restoration will be an improvement compared to the riparian zone's state prior to the 2017 flood event, which will aid in water quality, thereby benefiting aquatic life.* *The public access easements that are located on 401 Northwood Way will remain in effect.*
☐	☐	☒	**17.88.050(E)8**	**Building setback in excess of the minimum required along waterways is encouraged. An additional ten foot (10') building setback is encouraged to provide for yards, decks and patios outside the twenty five foot (25') riparian zone.**
			Staff Comments	*N/A, no new building is proposed.*
☐	☐	☒	**17.88.050(E)9**	**The top of the lowest floor of a building located in the one percent (1%) annual chance floodplain shall be a minimum of twenty four inches (24") above the base flood elevation of the subject property. (See section 17.88.060, figures 1 and 2 of this chapter.)**

Compliant			Standards and Staff Comments	
Yes	No	N/A	Guideline	City Standards and *Staff Comments*
			Staff Comments	*N/A, no new building is proposed.*
☐	☐	☒	**17.88.050(E)10**	**The backfill used around the foundation in the floodplain shall provide a reasonable transition to existing grade but shall not be used to fill the parcel to any greater extent. Compensatory storage shall be required for any fill placed within the floodplain. An LOMA-F shall be obtained prior to placement of any additional fill in the floodplain.**
			Staff Comments	*N/A, no new building is proposed.*
☐	☐	☒	**17.88.050(E)11**	**All new buildings shall be constructed on foundations that are approved by a licensed professional engineer.**
			Staff Comments	*N/A, no new building is proposed.*
☐	☐	☒	**17.88.050(E)12**	**Driveways shall comply with effective street standards; access for emergency vehicles has been adequately provided for.**
			Staff Comments	*N/A, no alteration of driveway is proposed.*
☐	☐	☒	**17.88.050(E)13**	**Landscaping or revegetation shall conceal cuts and fills required for driveways and other elements of the development.**
			Staff Comments	*N/A, no alteration of driveway is proposed.*
☒	☐	☐	**17.88.050(E)14**	**(Stream alteration.) The proposal is shown to be a permanent solution and creates a stable situation.**
			Staff Comments	*The applicant's engineer has designed the stream channel to be a permanent and stable solution. Bank stabilization, protection of the mouth of the eastern side channel, and the buried rock sill are designed to further ensure stability.* *Monitoring and maintenance are addressed in Section G of the restoration plan dated September 30, 2019 and are approved as conditioned by this permit.*
☒	☐	☐	**17.88.050(E)15**	**(Stream alteration.) No increase to the one percent (1%) annual chance floodplain upstream or downstream has been certified, with supporting calculations, by a registered Idaho hydraulic engineer.**
			Staff Comments	*The applicant's engineer has completed a no-rise analysis and submitted a no-rise certification.*
☒	☐	☐	**17.88.050(E)16**	**(Stream alteration.) The recreational use of the stream including access along any and all public pedestrian/fisherman's easements and the aesthetic beauty is not obstructed or interfered with by the proposed work.**
			Staff Comments	*401 Northwood Way contains a 10' wide Fisherman's Access Easement providing public access to the river and a 10' Fisherman's / Pedestrian Access / Nature Study easement, offset 10' landward from the eastern bank of the Big Wood River, that is dedicated to the public.* *Prior to the 2017 flood, neither access into the river channel via the pedestrian access easement nor access along the easement that parallels the bank were inhibited by physical barriers. The bank stabilization treatment proposed may introduce access challenges for persons with mobility impairments (climbing onto and over riprap). As such, staff includes as a condition of approval that the bank stabilization material placed in the most upland (least prone to bank overtopping during highwater) 5' section of the 10' wide Fisherman's Access Easement be arranged in an intentional, deliberate manner to mimic a 'stairstep' leading into the river channel.*
☐	☐	☒	**17.88.050(E)17**	**(Stream alteration.) Where development is proposed that impacts any wetland, first priority shall be to move development from the wetland area. Mitigation strategies shall be proposed at time of application that replace the impacted wetland area with**

Compliant			Standards and Staff Comments	
Yes	No	N/A	Guideline	City Standards and *Staff Comments*
				a comparable amount and/or quality of new wetland area or riparian habitat improvement.
			Staff Comments	*N/A, the subject property does not contain wetlands.*
☒	☐	☐	**17.88.050(E)18**	**(Stream alteration.) Fish habitat shall be maintained or improved as a result of the work proposed.**
			Staff Comments	*Use of woody treatments in the eastern side channel's stabilization will aid in maintaining fish habitat. Juvenile fish have been observed in this side channel. Incorporation of woody treatments into the stabilization of the bank of the main channel of the river will aid in maintaining fish habitat as well.* *Removal of the woody debris that has accumulated post-2017 flood will disrupt fish habitat. However, upon completion of this project, the willows and woody treatment incorporated into the stabilized bank should enhance the fish habitat above and beyond the habitat that existed adjacent to the eastern bank of the main channel prior to the 2017 flood. Prior to the 2017 flood the eastern bank of the river contained little to no riparian vegetation and showed signs of incision.*
☒	☐	☐	**17.88.060(E)19**	**(Stream alteration.) The proposed work shall not be in conflict with the local public interest, including, but not limited to, property values, fish and wildlife habitat, aquatic life, recreation and access to public lands and waters, aesthetic beauty of the stream and water quality.**
			Staff Comments	*The proposed work is designed to strike a balance between private property values and the natural characteristics of the main and eastern side channel of the Big Wood River, the floodplain, and riparian area, as such natural characteristics of an unaltered landscape relate to fish and wildlife habitat, aquatic life, recreation, access to the river, aesthetic beauty of the river, and water quality.*
☐	☐	☒	**17.88.060(E)20**	**(Stream alteration.) The work proposed is for the protection of the public health, safety and/or welfare such as public schools, sewage treatment plant, water and sewer distribution lines and bridges providing particularly limited or sole access to areas of habitation.**
			Staff Comments	*N/A.*

CONCLUSIONS OF LAW

1. The City of Ketchum is a municipal corporation organized under Article XII of the Idaho Constitution and the laws of the State of Idaho, Title 50, Idaho Code;

2. Under Chapter 65, Title 67, of the Idaho Code the City has passed a zoning ordinance, Title 17;

3. The City of Ketchum Planning Department provided adequate notice of opportunity to comment on this application pursuant to Chapter 17.88 of the zoning ordinance, Title 17;

4. The Administrator has authority to hear the applicant's Preliminary Plat Application pursuant to Section 17.88.050.D.1 of Ketchum Municipal Code, Title 17;

5. The project **does** meet the standards of approval under Chapter 17.88 of Zoning Code Title 17.

DECISION

THEREFORE, the Administrative Floodplain Development Permit for the proposed project, Swan Stream Alteration/Bank Stabilization, is approved on this date, October 11th, 2019, with the following conditions:

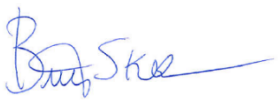
1. This approval is subject to the scope of work described in the following documents:
    a. Swan Property Restoration Plan: Stream Alteration and Floodplain Development Permit Applications: Final for City Approval, Brockway Engineering, PLLC, dated September 30, 2019
    b. Swan, Sandra River Restoration Project sheets 0-3, Brockway Engineering, PLLC, dated September 16, 2019
    c. Draft River Restoration, Swan Residence, BYLA, dated September 16, 2019 with the exception of Zone 2 riparian grasses, which shall be the seed mix specified in the September 30, 2019 Brockway Engineering plan.
2. Commencement of construction of any component of this project is subject to approval by the City Council of an Encroachment Agreement and any conditions of approval for the Encroachment Agreement imposed by Council.
3. Commencement of construction of any component of this project is subject to written approval from the adjacent upstream property owners, Marsupial Properties LLC (Alison and Geoffrey Rusack), and/or their attorneys, to the City of Ketchum, attention: Brittany Skelton, Planning and Building Department, because the scope of work includes alteration of the Rusack's private property 411 Northwood Way (Lot 1, Resub of Northwood PUD).
4. The owner's representative shall notify the City of Ketchum Senior Planner Brittany Skelton via e-mail 48 hours in advance of the day construction of the project is scheduled to begin and notify via e-mail on the day construction begins.
5. The owner's representative shall notify the City of Ketchum Senior Planner Brittany Skelton via e-mail within 48 hours of the next business day after the scope of work is complete.
6. The owner's representative shall facilitate a site visit with city staff to occur within five (5) business days of completion of the project.
7. Within 30 days of completion of the project the owner's representative shall submit a construction completion report certifying the project has been completed as proposed. This report shall at minimum include:
    a. A letter prepared and stamped by Brockway Engineering confirming the project was completed in accordance with the plans dated September 16 and September 30, 2019.
        i. Verify elevations of reclaimed areas and top of bank or riprapped portions of streambank do not exceed elevations specified in plans
        ii. Survey cross sections to show channel graded as proposed
        iii. Verify mouth to east side channel constructed as proposed
    b. A letter prepared by Ben Young Landscape Architects confirming landscaping has been installed as indicated in the plan dated September 16, 2019, with the exception of the riparian seed mix, which shall be per the seed mix specified in the September 30, 2019 Brockway plan
8. Follow up reports Monitoring Reports due to the city by December 31, 2020, 2021, and 2022. Monitoring reports to reflect all maintenance performed during the given calendar year.
9. For the purpose of maintaining the public access to the river, bank stabilization material placed in the most upland (least prone to bank overtopping during highwater) 5' section of the 10' wide

Fisherman's Access Easement shall be arranged in an intentional, deliberate manner to mimic a 'stairstep' leading into the river channel.

10. Maintenance of barbs, riprap, and east sill shall be limited to reconfiguration of dislodged material used in original construction.
    a. Replacement of any material that has been washed downstream may be approved administratively if quantity does not exceed 1 cubic yard per year.
11. Floodplain Development Permit approval shall expire one (1) year from the date of signing of approved Findings of Fact per the terms of KMC, Section 17.88.050.G, Terms of Approval;
12. No use of restricted use chemicals or soil sterilants will be allowed within one hundred feet (100') of the mean high-water mark on any property within the city limits at any time (KMC 17.88.040.C.3);
13. No use of pesticides, herbicides, or fertilizers will be allowed within twenty-five feet (25') of the mean high water mark on any property within the City limits unless approved by the City Arborist (KMC 17.88.040.C.4);
14. All applications of herbicides and/or pesticides within one hundred feet (100') of the mean high water mark, but not within twenty five feet (25') of the mean high water mark, must be done by a licensed applicator and applied at the minimum application rates (KMC 17.88.040.C.4);
15. Application times for herbicides and/or pesticides will be limited to two (2) times a year; once in the spring and once in the fall unless otherwise approved by the City Arborist (KMC 17.88.040.C.5);
16. The application of dormant oil sprays and insecticidal soap within the Riparian Zone may be used throughout the growing season as needed (KMC 17.88.040.C.6);
17. It shall be unlawful to dump, deposit or otherwise cause any trash, landscape debris or other material to be placed in any stream, channel, ditch, pond or basin that regularly or periodically carries or stores water.

Decision: Approved, subject to conditions above.

DATED this 11th day of October, 2019



Brittany Skelton
Senior Planner, CFM

Attachments:

A. Swan Property Restoration Plan: Stream Alteration and Floodplain Development Permit Applications: Final for City Approval, Brockway Engineering, PLLC, dated September 30, 2019
B. Swan, Sandra River Restoration Project sheets 0-3, Brockway Engineering, PLLC, dated September 16, 2019
C. Draft River Restoration, Swan Residence, BYLA, dated September 16, 2019

Public Comment:

1. Trout Unlimited, March 11, 2019
2. Wood River Land Trust, March 11, 2019
3. Katie Franklin, November 9, 2018
4. Trout Unlimited, October 29, 2018
5. Wood River Land Trust, October 29, 2018

6. Barbara Patton, October 29, 2018
7. John E. Philips, October 24, 2018
8. Donald White, October 23, 2018

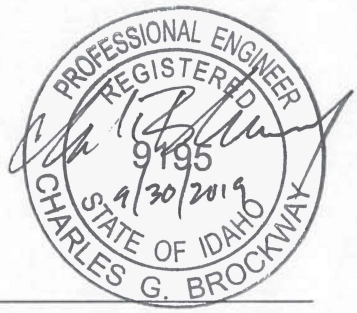
Included in the record:

I. Floodplain Management Overlay Application coversheet, signed by Sandra Swan and dated August 23, 2018
II. Swan Property Restoration Plan: Stream Alteration and Floodplain Development Permit Applications (including project drawings and HEC-RAS model results), Brockway Engineering, dated August 27, 2018
III. Project drawings and exhibits, Brockway Engineering, dated September 28, 2018
IV. Jennifer Zung, PE, Harmony Design & Engineering, memo dated October 11, 2018
V. Response to Review by Harmony Engineering of Swan Phase 2 Stream Alteration Permit Application, C. G. Brockway, PhD, PE, dated October 17, 2018
VI. Email, Charles G. Brockway to Brittany Skelton, dated October 17, 2018
VII. Letter, Bob and Sandra Swan, to Mayor Neil Bradshaw, Brittany Skelton and John Gaeddert, received via email from Robert Swan October 28, 2018
VIII. Email, Sandra Swan, dated November 6, 2018, with photo attachments
IX. Email, Jennifer Zung, dated November 9, 2018
X. Email, Charles G. Brockway, dated November 14, 2018, 3:40 p.m. with attachment, memo "Information Requested by Jennifer Zung Regarding Sandra Swan SAP Application", dated November 13, 2018
XI. Email, Jennifer Zung, dated November 14, 2018, 5:21 p.m.
XII. Email, Charles G. Brockway, dated November 14, 2018, 6:23 p.m.
XIII. Emails, Charles G. Brockway, dated November 16, 2018
XIV. Emails, Jennifer Zung, dated November 16, 2018
XV. Email, Jennifer Zung, dated November 26, 2018, with attachments
XVI. Revised stand alone revegetation plan, Brockway Engineering, dated December 7, 2018, including attachment, River Restoration landscape plan, BYLA, dated November 27, 2018
XVII. Letter, Brittany Skelton to Evan Robertson, dated December 10, 2018
XVIII. Swan, Sandra River Restoration Project plan set, Brockway Engineering, dated January 4, 2019
XIX. "No Rise" Certificate, Charles G. Brockway, PE, dated January 4, 2019
XX. HEC-RAS model files, Brockway Engineering
XXI. Response to City of Ketchum Deficiency Letter for the Swan Phase 2 SAP Application, Charles G. Brockway, dated January 4, 2019
XXII. Letter, Evan Robertson to Brittany Skelton, Aaron Golart (IDWR), John Gaeddert, and Tim Luke (IDWR) dated January 29, 2019
XXIII. Jennifer Zung, PE, Harmony Design & Engineering, memo dated February 20, 2019
XXIV. Swan, Sandra River Restoration Project plan set, Brockway Engineering, dated July 19, 2019
XXV. Swan Property Restoration Plan: Stream Alteration and Floodplain Development Permit Applications: Final for City Approval, Brockway Engineering, dated August 14, 2019
XXVI. Swan Property Restoration Plan: Stream Alteration and Floodplain Development Permit Applications: Final for City Approval, Brockway Engineering, dated September 16, 2019
XXVII. Swan, Sandra River Restoration Project plan set, Brockway Engineering, dated September 16, 2019
XXVIII. IDWR Amended Approval of Joint Application for Permit No. S37-20546, dated July 8, 2019
XXIX. IDWR Approval, in Part, of Joint Application for Permit No. S37-20546, dated February 28, 2019
XXX. USACE permit NWW-2017-639-I02 dated September 11, 2018

XXXI. Email, Frank Edelmann, Idaho Fish and Game, September 19, 2018
XXXII. Email, Kristine Hilt, Blaine County, September 20, 2018
XXXIII. Email, Frank Edelmann, Idaho Fish and Game, September 24, 2018
XXXIV. Public comment
XXXV. Site photos dated September 27, 2010 (Ketchum Planning and Building Department)
XXXVI. Site photos dated May 11, 2017 (Ketchum Planning and Building Department)
XXXVII. Site photos dated May 24, 2017 (Ketchum Planning and Building Department)
XXXVIII. Site photos dated April 6, 2018 (Ketchum Planning and Building Department)
XXXIX. Site photos dated May 2, 2018 (Ketchum Planning and Building Department)
XL. Site photos dated November 1, 2018 (Ketchum Planning and Building)
XLI. Site photos dated November 2, 2018 (Ketchum Planning and Building)
XLII. P15-144 Findings of Fact, Conclusions of Law, and Decision
XLIII. P17-055 Findings of Fact, Conclusions of Law, and Decision
XLIV. P17-134 Findings of Fact, Conclusions of Law, and Decision
XLV. P19-044 Findings of Fact, Conclusions of Law, and Decision
XLVI. P19-047 Approval
XLVII. Chateaux of Northwood subdivision plat, 1995
XLVIII. City Council meeting minutes, January 13, 1992
XLIX. Planning and Zoning Commission meeting minutes, February 10, 1992
L. Planning and Zoning Commission meeting minutes, March 23, 1992
LI. Letter, Idaho Conservation League to Ketchum Planning and Zoning Commission, with attachment, dated March 23, 1992
LII. Planning and Zoning Commission meeting minutes, May 8, 1995

A. Swan Property Restoration Plan: Stream Alteration and Floodplain Development Permit Applications: Final for City Approval, Brockway Engineering, PLLC, dated September 30, 2019

Swan Property Restoration Plan: Stream Alteration and Floodplain Development Permit Applications: Final for City Approval



Charles G. Brockway, Ph.D., P.E.
Brockway Engineering, PLLC

September 30, 2019

The project scope and this narrative have been revised multiple times at the request of the City of Ketchum. In the previous version, the erosion protection of the reclaimed land on the floodplain was removed from the project. This change was necessary to obtain an administrative approval of the permit, and is not desired by the applicant nor recommended by the project engineer. Newly-placed soil must be protected from erosion so that it does not wash away during sheet flooding, which may lead to exactly the same situation that exists today; vegetation alone is insufficient. In the present version, the language has been clarified in a few locations as requested by the City. This revised narrative pertains to City of Ketchum permitting only.

A. Background

This project consists of a follow-up to previously-permitted work to address flooding on the applicants' property. Previously-issued permits include the following:

1. Removal of a large debris dam which had formed during the flood of 2017. The dam had raised water levels, caused major gravel deposition in the main river channel, and caused water to leave its banks and cut eastward through the applicant's yard. This dam was the primary source of the flooding problems on the subject property and its removal was the first step toward a long-term solution.

2. Emergency work in May 2018 to place 1-yard gravel bags across the breach area. Even though runoff magnitude in 2018 was moderate (a peak flow of only 836 cfs), water overtopped the bank and cut eastward and the bags were placed to prevent further property damage. At this flow, there would have been zero floodplain inundation but for the gravel deposition in the river channel.

The current proposal is intended to be a long-term solution to the ongoing threat to the applicant's property. Due to gravel deposition in the channel to depths of 2 to 3 feet in 2017, confirmed by topographic surveys, river water levels are now nearly the same as the elevation of the applicant's adjacent property even at base flows. In 2018, water overtopped the bank at very low flows of 150 to 200 cfs. The river continued to cut a channel eastward through the property, exacerbating the erosion that occurred in 2017. This erosion was finally halted by the emergency placement of the gravel bags, but not before major damage to land had occurred. The same effects were observed in 2019,

during which the peak flow was slightly above the median level. The flow in 2019 was not sufficient to mobilize gravel or cause channel changes to any significant degree. The river channels today are essentially in the same configuration as when the permit application was originally submitted in August 2018.

Topographic surveys were performed in November 2017 and July 2018. As noted above, no channel changes have occurred and no new surveying was or will be completed in 2019. Comparing the 2017 and 2018 datasets, it is evident that the runoff in 2018, even though it was very high, failed to mobilize the gravel deposition in any appreciable quantities. The data confirms what is evident by visual inspection –the gravel deposition must be removed in order to restore conveyance to this reach and prevent the river from cutting a new channel eastward through private property.

At the same time, the east floodplain should continue to function as it has historically, but without allowing the major erosion observed in 2017 and 2018. Sheet flow in this area is appropriate and consistent with historical occurrence; however, the river cutting a major new channel through private property is not. This objective will be accomplished by regrading and protecting the floodplain as described below.

The minor channel known as the "East Channel" has important riparian value and should be maintained and protected. This channel has historically flowed year-round and has contributed significantly to flood-carrying capacity of the river system. These values should be preserved, but the channel must be stabilized to prevent it from turning into a major river channel and impacting adjacent properties.

Finally, bank protection measures consisting of both rock and wood-based treatments are warranted along the excavated banks to prevent undercutting and potential bank failure.

The project consists of seven (7) components. The components are described below and are illustrated on the accompanying drawings.

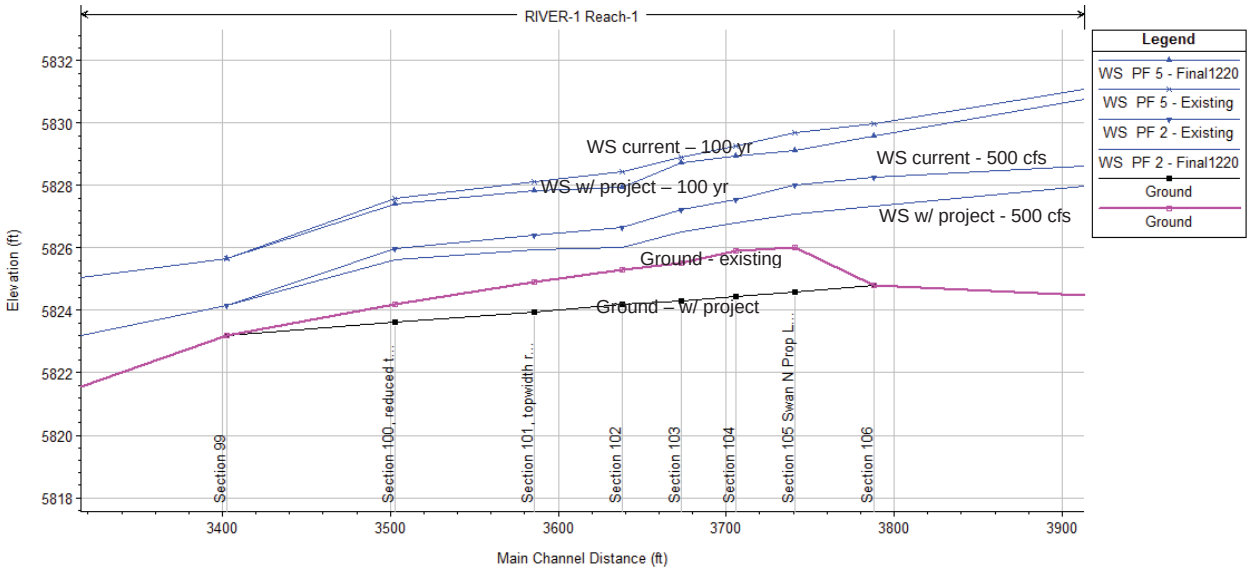
B. Project Components

1. Removal of gravel and sediment deposition

The accretion of gravel in 2017 did not adequately mobilize in 2018 and very little gravel was transported. Gravel must be removed and the channel re-graded to a stable section which can transport flows without overtopping the east bank except in very high flow conditions, as it has historically. The figure below shows the existing channel "hump" of gravel and the proposed grade. Also shown are computed values of the water surface at a flow of 500 cfs and the 100-year flow.

The grade of the channel was set by assuming a constant gradient from the northern to the southern cross-section (see plan drawing). This results in a slope of 1.1%. The excavated channel will be generally trapezoidal, with bottom width varying from 40 to 60

feet and side slope of 4:1. The exception is at section 106 north of the Swan property line, which must have a narrower section to match property with adjacent conditions. The hydraulic modeling performed for the project indicates that this geometry will result in a net decrease in water levels at all river flows (see Section E, below).



Excavated gravel will be utilized for the reclamation component, but most of the gravel will be excess and will be hauled off site.

The logistics of river channel construction dictate that some material stockpiling must occur in the dry channel for a very short time. A typical approach would involve one loader excavating the channel to grade, and a second loader picking up stockpiled material and transporting it out of the channel.

2. Reclamation of eroded land

This component will involve restoring eroded turf and riparian areas to substantially pre-2017 extents and grade, i.e. prior to the discrete flood event of 2017. This area must still be allowed to function as a flood plain, but must be adequately protected from erosion. Original grade was estimated from the topographic survey data collected in 2017 and 2018, in which the surveyor was directed to obtain shots from obvious pre-flood points such as bases of trees, undisturbed turf areas, etc. These data were used to estimate final grade elevations and a contour map for the landscaper to follow. Final grades were set approximately 0.5' higher than estimated pre-flood grades to account for soil settling and the overall higher flood elevations due to gravel deposition (see Section E).

It will be vitally important to ensure that the reclaimed area can withstand shallow sheet flow without succumbing to the erosion seen in 2017 and 2018. The modeling indicates that during the 100-year event as much as 232 cfs (8% of the total streamflow) will flow

in the east floodplain at velocities from 1.4 to 2.0 ft/s. To obtain an administrative approval, the City has prohibited the inclusion of a stabilization product and therefore it is not included in the plan.

The reclaimed area will be revegetated with same or similar vegetation that was in place prior to the 2017 flood, including turfgrass. However, appropriate riparian vegetation will be used in the 25-foot riparian zone, and riparian woody shrubs will be incorporated to increase surface roughness and provide habitat value. See the revegetation plan, Section F, and the attached revegetation map from BYLA.

3. Protection of southern boundary of reclaimed land

This component involves armoring the south boundary of reclaimed land. The reason for this action is twofold: 1) water flowing southeasterly over the reclaimed area during a flood will "fall" into the east channel, which is an erosion risk, and 2) the east channel flow itself could undercut and erode the southern boundary of the reclaimed area. The armoring treatment will include riprap with willow plantings.

4. Stabilization of East Channel entrance

Water should be allowed to flow into East Channel, but the channel is now at risk of down-cutting and allowing excessive flow to occur. The flood risk to owners of property along the channel has been elevated significantly. During the 2018 runoff, very large amounts of water entered the channel – much more than would ordinarily occur during such a modest runoff event. The objective is to reestablish the channel as a functioning minor channel that will both increase flood conveyance and provide water supply for riparian values during low river flows, as it has for many years. The intent is to put the channel back in essentially the same configuration as it was historically, but with sufficient protection at the entrance.

The work involves re-grading the unstable entrance section of the channel from the river to about 80 feet downstream, and placing erosion protection consisting of 1) a rock sill across the channel to prevent downcutting, and 2) a rip-rap blank upstream and downstream of the sill consisting of buried rock and embedded root wads. These measures are intended to prevent down-cutting and stabilize the flow into the channel.

5. Bank stabilization

This component includes log barbs embedded in the east bank of the river and projecting into water at the toe of the slope. Between the barbs, toe logs, rock, and additional wood will be placed. The benefits of this action include erosion protection, encouraging the high velocity flow to remain waterward of the bank, encouraging the river to curve westward, and improving habitat.

6. Buried rock sill

A line of rock will be buried along the top of the bank to provide a final backstop against downcutting or bank migration in the event of a severe, unforeseen occurrence. The top of the rock will be about 8" below finished grade and approximately 10 feet waterward of the ordinary high water mark.

7. Removal of debris and at-risk trees

Woody debris and unstable trees will be removed and the wood utilized in the bank protection measures wherever possible. Tree removal will be minimized to the extent possible, but it is vital that unstable trees which may fall into the river and restart the debris dam accretion process be removed. The removal areas are specifically designated on the plan drawing. Trees on city property as marked in the field will be removed, and deadwood on city property in the area of water bypass will likely need to be removed to accomplish the bypass. It appears likely that all woody material can be utilized in the project.

C. Quantities

Quantities of excavation and fill were calculated for components #1 through #5 and are shown in Table 1. OHW was assumed to be the line existing prior the 2017 discrete event. Component #6 involves work landward of the OHW and therefore no quantities are given. Component #7 involves removal of trees and debris and the volume is difficult to estimate.

As noted in Table 1, the total volume of gravel removal is 1,423 cubic yards. Of this amount, gravel removal proposed on City of Ketchum property, which would occur at Sections 104, 105, and 106 is estimated to be 215 cubic yards. Additional detailed information on the channel grading after gravel removal activity is provided in Table 2, including cross-sectional areas of removal and channel geometry.

D. Water Bypass

The project work area will be dewatered to reduce or eliminate turbidity impacts and to allow proper grade and geometric control on all features of the project. This will be accomplished by placing 1-yard gravel bags north of the work and diverting the flow into the western river channel at a location which is feasible and will provide the necessary flow path. To do this will likely require removal of the debris as shown on the plan drawing and may require creation of a shallow bypass channel across the gravel bar on City property, not on the Community Library's property. It is possible that the gravel bags alone will be sufficient to bypass the flow, depending on the magnitude of the river flow. Material removed for the bypass channel will be temporarily placed on the gravel bar just adjacent to the channel and the gravel bar restored after the work is complete.

Table 1. Quantities.

Project Component	River Length (ft)	Plan Area (acres)	Total excavation (cu. yd.)	Excavation below OHW* (cu. yd.)	Total fill (cu. yd.)	Fill below OHW* (cu. yd.)
1. Gravel removal	405	0.54	1,423	1,423	0	0
2. Reclamation	n/a	0.27	0	0	447	0
3. Reclaimed land south boundary protection	165	0.03	0	0	77	65
4. East chan entrance stabilization	88	0.03	86	86	54	54
5. Bank stabilization	252	0.06	0	0	183	183
6. Gabions	Landward of OHW					
7. Wood removal	n/a	0.10	150	150	0	0
Temporary bypass and coffer	32	0.03	65	65	18	12
TOTALS		1.05	1,724	1,724	586	314
TOTALS (not including temporary work)		1.02	1,659	1,659	568	302

Notes:
Gravel removal: Length is total north-south length along Big Wood River from upper to lower limits of removal.
Reclamation: Fill volume is for reclamation of land within floodplain.
Reclaimed land south boundary protection: Length is west-east along north bank of East Channel.
East channel entrance stabilization: Length is the west-east length of the east channel entrance protection and re-grading; total excavation is for channel re-grading from entrance eastward; fill is rock at entrance.
Bank stabilization: Length is north-south along Big Wood River, fill is riprap and logs.
* OHW prior to 2017 discrete event.

Table 2. Post-project channel geometry.

Section	River Station (ft)	Bottom width (ft)	Side slope	Cut area (ft2)
106	106085	20	2:1	25
105	106038	30	4:1	98
104	106003	40	4:1	114
103	105970	40	4:1	113
102	105935	50	4:1	154
101	105883	60	4:1	96
100	105800	60	4:1	116
99	105700	30	4:1	21

E. HEC-RAS Modeling

Hydraulic modeling using HEC-RAS 4.1 was performed for the project. The FEMA effective model for the Big Wood River was run, and found to reproduce the base flood elevations at Sections EN and EM. The project is located between these two sections.

Eight new cross-sections were developed using the survey data described above to reflect current conditions through the project reach. The same roughness coefficients used by FEMA were used for the new cross-sections.

A Corrected Effective model was developed by inserting the new cross-sections and adjusting reach lengths accordingly. A Post-Project model was developed which incorporates both the reclamation of land within the floodplain, the proposed gravel removal, and the bank stabilization actions.

The Corrected Effective model indicates that current 100-year flood heights are 1.1 to 1.3 feet greater than the published base flood elevations due to the gravel deposition described herein.

With the proposed project in place the Post-Project model indicates reductions in flood height compared to the Corrected Effective model during the 100-year event and all other flows in the river. The reduction in water level adjacent to the applicant's property will be considerable as shown in Table 3. The model indicates that the project clearly meets the required "no-rise" criteria for work within a regulatory floodway, as it will result in a decrease in 100-year flood height compared to current conditions.

Table 3. Change in computed water level from existing (Corrected Effective) to Post-Project conditions.

Section	Streamflow (cfs)				
	100	500	1000	2000	2880 (100-yr)
106	-0.95	-0.98	-0.88	-0.66	-0.42
105	-1.21	-1.00	-0.84	-0.58	-0.63
104	-1.15	-0.88	-0.72	-0.55	-0.50
103	-1.05	-1.05	-0.78	-0.48	-0.38
102	-0.84	-0.79	-0.71	-0.82	-0.64
101	-0.78	-0.69	-0.54	-0.48	-0.46
100	-0.60	-0.56	-0.44	-0.38	-0.35

The model also indicates that the inundated area of the east 100-year floodplain on the applicant's property will be essentially the same as delineated by FEMA, i.e. no loss of floodplain value will occur. The model predicts the floodplain will begin to be inundated

at a flow of 1,400 cfs or about a 7-year event, which is an appropriate level. The model predicts the overland flow in the east floodplain during the 100-year event ranges from 77 to 232 cfs through the study reach. In short, the floodplain conveyance is being adequately preserved.

F. Revegetation Plan

Revegetation of the all disturbed areas will be a vital component of the restoration plan. The project is divided in two three revegetation zones according to the treatment received: the reclaimed area outside of the riparian zone, the 25-foot riparian zone, and the bank stabilization zone. Each treatment is described below. Consultation was made with the owner's landscape professional, Ben Young Landscape Architects (BYLA), to refine the plan from the original plan submitted with the application. The plan described below and depicted on the attached map from BYLA is consistent with the plan approved by IDWR and will supersede any previously-submitted plans.

Zone 1: Reclaimed land outside of the 25-foot riparian zone:

Grasses
Match original vegetation: Scottish Links Fine Fescue by Magic Valley Sod.

Shrubs (3 per 1000 ft^2)

Golden currant	*Ribes aureum*
Red-osier dogwood	*Cornus sericea*
River alder shrub	*Alnus incana*
Woods rose	*Rosa woodsii*

Cottonwood seedlings (5)

Zone 2: Riparian zone within 25 feet of ordinary high water (prior to 2017 discrete event) of the Big Wood River and East Channel

Note: the riparian grass list has been modified slightly to reflect the requirements of the City in order to obtain administrative approval.

Riparian Grasses (approximately equal proportions)

Idaho fescue	*Festuca idahoensis*
Streambank wheatgrass	*Agropyron riparium*
Creeping red fescue	*Festuca rubra*
Bluebunch wheatgrass	*Pseudoroegneria spicata*
Silky lupine	*Lupinus sericeus*

Shrubs (12 per 1000 ft^2)

Golden currant	*Ribes aureum*
Red-osier dogwood	*Cornus sericea*
River alder shrub	*Alnus incana*
Woods rose	*Rosa woodsii*

Zone 3: Bank stabilization

Booth willow	*Salix boothii*
Geyer willow	*Salix geyeria*
Pacific willow	*Salix lasiandra*

Planting Methods and Coverage

The owner's landscape professional will be retained to oversee and/or perform the revegetation work in accordance with the specifications herein.

The reclaimed area will be topped with 6 inches of organic-rich topsoil and graded to provide an adequate seed bed. Grasses will be planted by the hydroseed method at 25 lb/acre or as recommended by the landscape professional. Broadcast application will only be used in areas unreachable by hydroseeding equipment.

Shrubs will typically be 1-gallon or 5-gallon containerized nursery stock, planted in accordance with accepted practices for containerized plantings. The shrub location and density will be selected to harmonize with existing vegetation, with target coverages described above. An exact number of shrubs cannot be specified.

Willow plantings within the bank stabilization will be made at a target spacing of 6 feet, with the willows placed deep enough to reach permanent water.

G. Monitoring and Maintenance

At the City's request, the performance of the project will be monitored for a period of three (3) years from the date of completion. Monitoring is agreed to by the owner only if the permit from the City also allows maintenance to address damage found during the monitoring period under the existing permit and without a new permit process.

Monitoring will consist of a site inspection and qualitative assessment by a qualified professional incorporating the following items:

1. Riprap integrity
2. Barb integrity
3. East channel sill integrity

4. East channel flow rate magnitudes at different river levels
5. Gravel and debris accumulation
6. Vegetation establishment, target survival 80% after 3 years

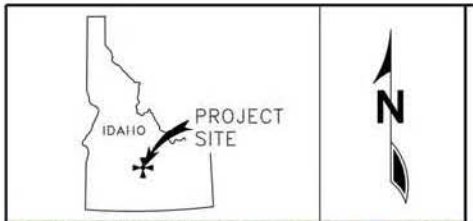
It is understood that debris accumulation/felled trees located outside of the bank stabilization area included in the scope of this permit, both waterward of the ordinary high water mark and landward of the ordinary high water mark and within the boundaries of the special flood hazard area, are subject to a separate permit process. A report will be submitted to the City by December 31 of each year during the monitoring period.

H. Construction Drawings

The City has requested final plans for the project. In anticipation of permit approval and project construction, a set of construction drawings have been prepared on 18"x24" sheets. These drawings contain four sheets: a cover page with specifications, plan view, details, and sections. As noted above, these have been modified slightly from the originally-submitted 8-1/2" x 11" drawings in accordance with the above discussions. The cross-sections shown thereon are the basis of the HEC-RAS modeling. The City is being provided with these large-format plans, as they are easier to follow than smaller-scale sheets. These plans are noted as Revision F and reflect the exclusion of the erosion protection product on the reclaimed land for the City only.

B. Swan, Sandra River Restoration Project sheets 0-3, Brockway Engineering, PLLC, dated September 16, 2019

SWAN, SANDRA
RIVER RESTORATION PROJECT



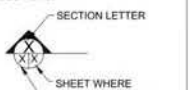
VICINITY MAP

ABBREVIATION LIST

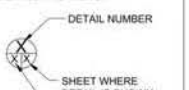
A	
&	AND
@	AT
C	
CL.	CENTER LINE
CONC.	CONCRETE
CMP.	CORRUGATED METAL PIPE
CULV.	CULVERT
D	
D	DEPTH
DIA., Ø	DIAMETER
D.I.	DUCTILE IRON
E	
EL., ELEV.	ELEVATION
EXT'G	EXISTING
E.W.	EACH WAY
G	
GALV.	GALVANIZED
I	
I.E.	INVERT ELEVATION
IN, "	INCH
M	
MAX.	MAXIMUM
MFG.	MANUFACTURE
MJ.	MECHANICAL JOINT
MIN.	MINIMUM
N	
N.T.S.	NOT TO SCALE
NO. OR #	NUMBER
O	
O.D.	OUTSIDE DIAMETER
P	
PVC.	POLYVINYL CHLORID
R	
R., RAD.	RADIUS
S	
S.S.	STAINLESS STEEL
STD.	STANDARD
STRU.	STRUCTURE
T	
T.O.C.	TOP OF CONCRETE
T.O.W.	TOP OF WALL
TYP.	TYPICAL
V	
VLV	VALVE
W	
W.S.E.	WATER SURFACE ELEV
W/	WITH

DETAILING CONVENTIONS

SECTIONS:



DETAILS AND VIEWS:



ESRI WORLD IMAGERY

GENERAL NOTES:

1. THE PROJECT CONSISTS OF THE COMPONENTS ILLUSTRATED AND DESCRIBED ON SHEET 1 OF THIS PLAN SET.
2. ALL TECHNICAL QUESTIONS REGARDING ANY ASPECT OF THE PROJECT SHALL BE DIRECTED TO BROCKWAY ENGINEERING C/O CHARLES G. BROCKWAY, P.E., 2016 WASHINGTON ST. NORTH #4, TWIN FALLS, ID 83301, (208) 736-8543.
3. CONTRACTOR SHALL VERIFY AND CONFIRM ALL DIMENSIONS AND CONDITIONS SHOWN OR IMPLIED ON THE DRAWINGS AND SPECIFICATIONS, AS WELL AS THE EXISTING WORK AND PHYSICAL DESCRIPTIONS AND CONDITIONS OF THE SITE, AND SHALL NOTIFY ENGINEER OF ANY DISCREPANCIES PRIOR TO THE START OF THE WORK.
4. ALL EQUIPMENT PROPOSED TO BE SUPPLIED BY THE CONTRACTOR MUST BE SUBMITTED FOR APPROVAL TO THE ENGINEER. ANY ITEM WHICH THE CONTRACTOR PROPOSES TO FURNISH AS "EQUAL" OR "EQUIVALENT" TO ITEM SPECIFIED SHALL BE SUBMITTED FOR APPROVAL TO THE ENGINEER WITH SUFFICIENT MANUFACTURER'S LITERATURE TO DETERMINE EQUIVALENCY.
5. UNDERGROUND UTILITIES MAY BE PRESENT. LOCATIONS ARE APPROXIMATE. CONTRACTOR SHALL CONTACT DIGLINE PRIOR TO CONSTRUCTION AND VERIFY LOCATIONS. CONTRACTOR SHALL COORDINATE WITH OWNER'S REPRESENTATIVES TO DETERMINE HOW NEW WATER PIPELINE WILL AVOID ALL UTILITIES.
6. THIS PROJECT IS AUTHORIZED UNDER PERMITS FROM THE U. S. ARMY CORPS OF ENGINEERS, IDAHO DEPARTMENT OF WATER RESOURCES, AND THE CITY OF KETCHUM. CONTRACTOR SHALL KEEP A COPY OF ALL PERMITS ON SITE AT ALL TIMES DURING CONSTRUCTION AND SHALL ADHERE TO ALL APPLICABLE CONDITIONS THEREIN.
7. ACCESS: PROJECT SITE SHALL BE ACCESSED THROUGH OWNER'S PROPERTY. CONTRACTOR SHALL MAKE APPROPRIATE ARRANGEMENTS WITH THE OWNER TO ACCOMPLISH THE WORK DESCRIBED HEREIN. ALL DAMAGE TO OWNER'S LAND, IMPROVEMENTS, OR INFRASTRUCTURE SHALL BE PROMPTLY REPAIRED TO OWNER'S SATISFACTION.
8. EARTHWORK: COMPLETE EXCAVATION TO GRADES AND DIMENSIONS SHOWN, TOLERANCE +/-0.2 FEET. EXCESS MATERIAL SHALL BE HAULED OFF SITE AND DEPOSITED IN UPLAND AREA.
9. RIP-RAP: GRANITE OR SOLID NON-VESICULAR BASALT, SIZE AS SHOWN, SUBSTANTIALLY FREE FROM CRACKS AND SEAMS, WITH DRY UNIT WEIGHT 165 LB/FT3 OR GREATER. NO LIMESTONE OR OTHER ERODIBLE MATERIAL SHALL BE USED. STONE SHALL BE BLOCKY IN SHAPE WITH SHARP, ANGULAR EDGES, STREAM-ROUNDED STONE IS NOT ACCEPTABLE. MINIMUM THICKNESS SHALL BE 30" FOR TYPE 1 AND 20" FOR TYPE 2.
10. BANK RIP-RAP GRADATION: STONE SIZE SHALL BE CHARACTERIZED BY W% AND D%, WHERE W IS STONE WEIGHT, D IS EQUIVALENT SPHERICAL STONE DIAMETER, AND % REPRESENTS THE PERCENTAGE OF THE TOTAL WEIGHT OF THE GRADED MATERIALS THAT CONTAINS STONES OF LESS DIAMETER OR WEIGHT. GRADATION OF THE STONE SHALL FALL WITHIN THE "MIN" AND "MAX" VALUES. THE UNIFORMITY COEFFICIENT, D85 / D15, SHALL BE NOT LESS THAN 1.4 AND NOT GREATER THAN 3.0

TYPE 1				
	W% (LB)		D% (INCHES)	
% FINER	MAX	MIN	MAX	MIN
0	137	50	14	10
15	255	108	17	13
30	383	199	20	16
50	511	345	22	19
90	1117	605	29	23
100	1723	689	33	24

TYPE 2				
	W% (LB)		D% (INCHES)	
% FINER	MAX	MIN	MAX	MIN
0	36	11	9	6
15	80	33	12	9
30	121	63	13	11
50	162	108	15	13
90	353	192	18	16
100	545	219	22	16

11. SILL ROCK: SPECIFICATIONS FOR RIP-RAP SHALL APPLY, BUT SIZE SHALL BE 18" TO 36".
12. GEOTEXTILE FABRIC: NON-WOVEN SYNTHETIC, CONTECH C-80NW OR EQUAL.
13. TOPSOIL: SANDY SILT LOAM OR SILT LOAM MATERIAL WITH MINIMUM 3% ORGANIC MATERIAL.
14. WOODY DEBRIS: RELOCATE DEBRIS CONSISTING OF TREES, ROOT BALLS, LIMBS, AND LIKE MATERIAL ONLY FROM THOSE AREAS DENOTED ON THE SITE PLAN. STOCKPILE MATERIAL OUTSIDE OF FLOODPLAIN, AND RETAIN ALL MATERIAL SUITABLE FOR INCORPORATION INTO BANK PROTECTION.
15. LANDSCAPING AND VEGETATION: FINAL GRADING AND VEGETATIVE PLANTINGS SHALL BE PERFORMED BY A LANDSCAPING CONTRACTOR UNDER A SEPARATE CONTRACT WITH THE OWNER. THE LANDSCAPING CONTRACTOR SHALL HAVE AT LEAST 5 YEARS EXPERIENCE IN THE LOCAL AREA. THIS WORK SHALL BE PERFORMED IN ACCORDANCE WITH A SEPARATE REVEGETATION PLAN DATED _____.
16. GRADED GRAVEL FILTER: 3/4 MINUS MATERIAL LESS THAN 5% PASSING 200 SIEVE, ACTUAL PRODUCT TO BE DETERMINED.

NOT FOR CONSTRUCTION

BROCKWAY ENGINEERING PLLC
HYDRAULICS · HYDROLOGY · WATER RESOURCES
2016 NORTH WASHINGTON, STE 4
TWIN FALLS ID, 83301
(208) 736-8543

DRAWING INDEX

REV	DESCRIPTION	DATE	APPD.	REFERENCE DRAWINGS
F	GEOGRID REMOVAL FOR CITY	9/16/19		
E	FOR FINAL PERMIT	7/19/19		
D	MODIFICATIONS TO CHANNEL	1/4/19		
C	ISSUE FOR CONSTRUCTION	10/18/18		
B	ADDED PROPERTY NAMES	9/28/18		
A	ISSUE FOR PERMITTING	8/27/18		

DESIGNED BY: CGB | DRAFTED BY: ICB

(18 X 24) DWG ONLY

BROCKWAY ENGINEERING, PLLC
HYDRAULICS - HYDROLOGY - WATER RESOURCES
2016 NORTH WASHINGTON, SUITE 4
TWIN FALLS ID, 83301
(208) 736-8543

SWAN, SANDRA
RIVER RESTORATION PROJECT

COVER SHEET & VICINITY MAP

PROJECT # 1436-02-2018

DWG # 0

REV F

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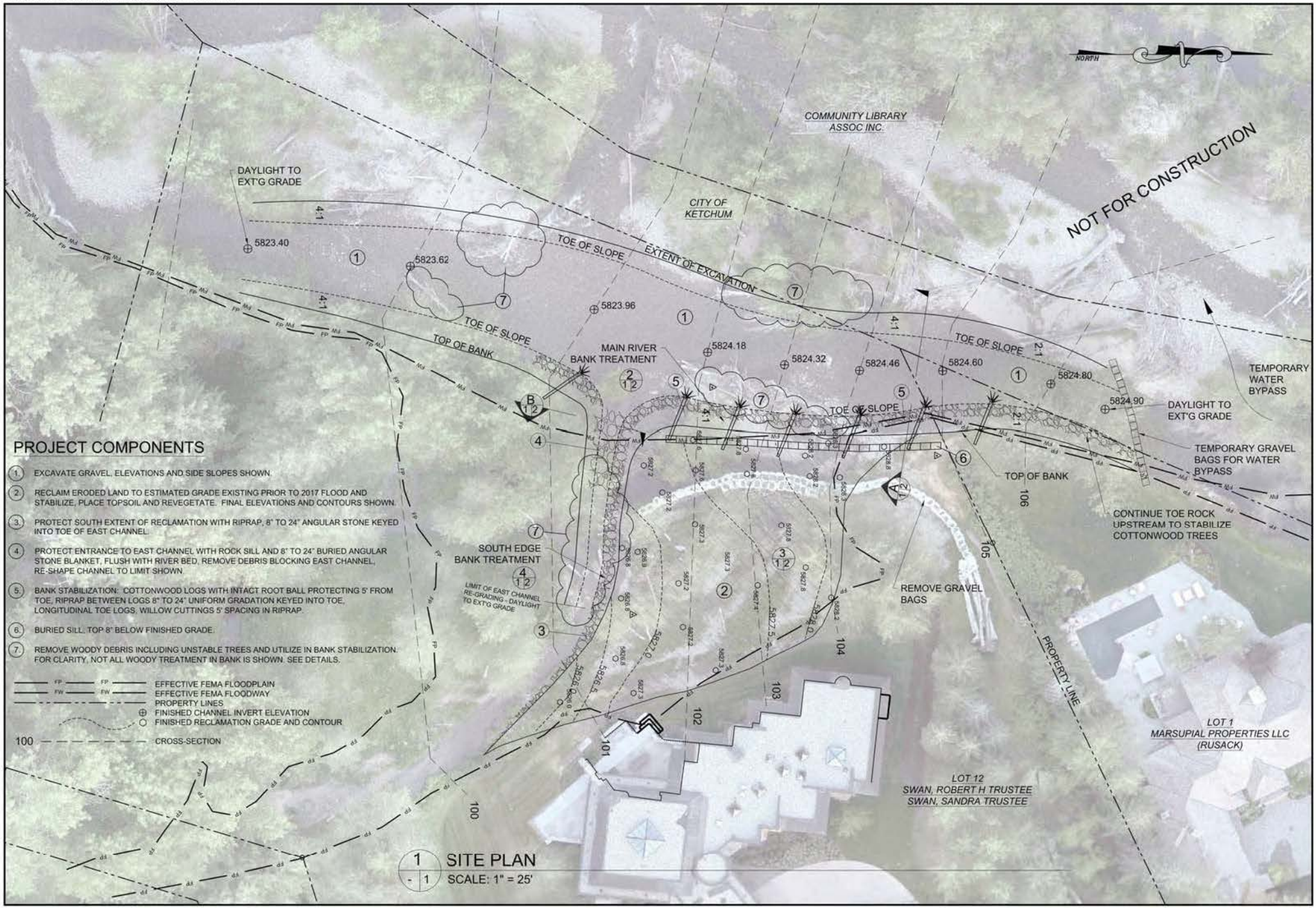


PROJECT COMPONENTS

1. EXCAVATE GRAVEL, ELEVATIONS AND SIDE SLOPES SHOWN.
2. RECLAIM ERODED LAND TO ESTIMATED GRADE EXISTING PRIOR TO 2017 FLOOD AND STABILIZE, PLACE TOPSOIL AND REVEGETATE. FINAL ELEVATIONS AND CONTOURS SHOWN.
3. PROTECT SOUTH EXTENT OF RECLAMATION WITH RIPRAP, 8" TO 24" ANGULAR STONE KEYED INTO TOE OF EAST CHANNEL.
4. PROTECT ENTRANCE TO EAST CHANNEL WITH ROCK SILL AND 8" TO 24" BURIED ANGULAR STONE BLANKET, FLUSH WITH RIVER BED, REMOVE DEBRIS BLOCKING EAST CHANNEL, RE-SHAPE CHANNEL TO LIMIT SHOWN.
5. BANK STABILIZATION: COTTONWOOD LOGS WITH INTACT ROOT BALL PROTECTING 5' FROM TOE, RIPRAP BETWEEN LOGS 8" TO 24" UNIFORM GRADATION KEYED INTO TOE, LONGITUDINAL TOE LOGS, WILLOW CUTTINGS 5' SPACING IN RIPRAP.
6. BURIED SILL, TOP 8" BELOW FINISHED GRADE.
7. REMOVE WOODY DEBRIS INCLUDING UNSTABLE TREES AND UTILIZE IN BANK STABILIZATION. FOR CLARITY, NOT ALL WOODY TREATMENT IN BANK IS SHOWN. SEE DETAILS.

FP —— FP —— EFFECTIVE FEMA FLOODPLAIN
FW —— FW —— EFFECTIVE FEMA FLOODWAY
PROPERTY LINES
⊕ FINISHED CHANNEL INVERT ELEVATION
○ FINISHED RECLAMATION GRADE AND CONTOUR
100 – – – – – – CROSS-SECTION

1 - 1 SITE PLAN
SCALE: 1" = 25'

REV	DESCRIPTION	DATE	APPD.	REFERENCE DRAWINGS
F	GEOGRID REMOVAL FOR CITY	9/16/19		
E	FOR FINAL PERMIT	7/19/19		
D	MODIFICATIONS TO CHANNEL	1/4/19		
C	ISSUE FOR BIDDING	10/18/18		
B	ADDED PROPERTY NAMES	9/28/18		
A	ISSUE FOR PERMITTING	8/27/18		

DESIGNED BY: CGB | DRAFTED BY: ICB
SCALE 1" = 25' (18 X 24) DWG ONLY

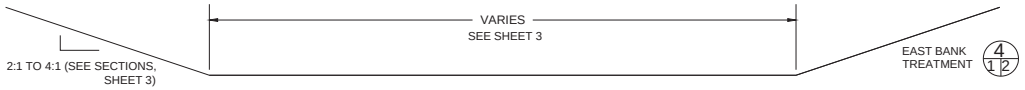
BROCKWAY ENGINEERING, PLLC
HYDRAULICS - HYDROLOGY - WATER RESOURCES
2016 NORTH WASHINGTON, SUITE 4
TWIN FALLS ID, 83301
(208) 736-8543

SWAN, SANDRA
RIVER RESTORATION PROJECT

SITE PLAN

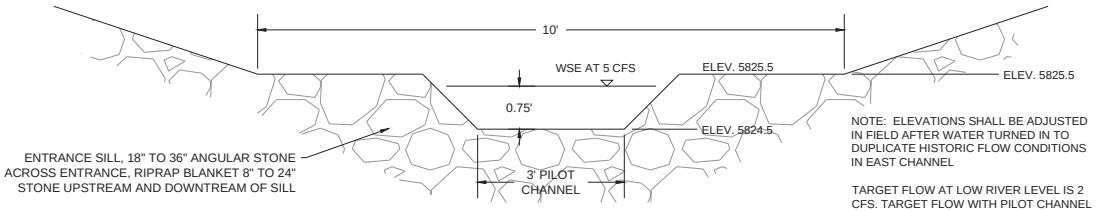
PROJECT # 1436-02-2018
DWG # 1
REV F

F:\Projects\Swan, Sandra\CAD - Phase 2\1436-02-2018-F.1-3.dwg



A MAIN RIVER CHANNEL TYP. SECTION
A 1 2
SCALE: N.T.S.

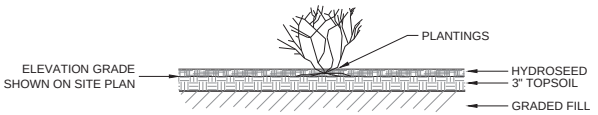
NOT FOR CONSTRUCTION



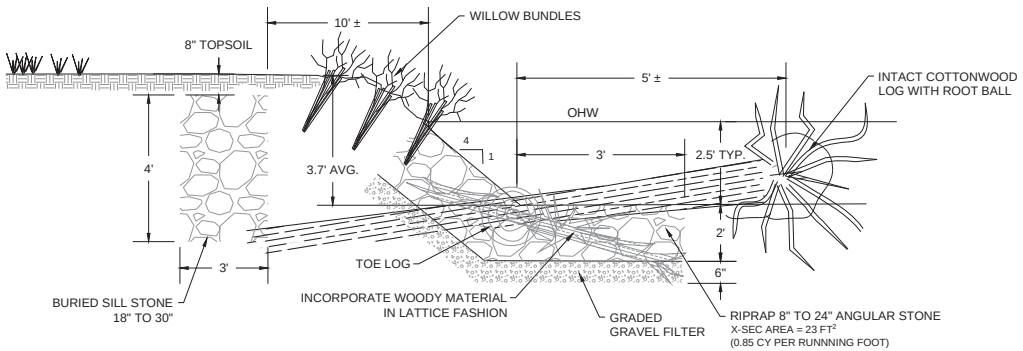
NOTE: ELEVATIONS SHALL BE ADJUSTED IN FIELD AFTER WATER TURNED IN TO DUPLICATE HISTORIC FLOW CONDITIONS IN EAST CHANNEL

TARGET FLOW AT LOW RIVER LEVEL IS 2 CFS. TARGET FLOW WITH PILOT CHANNEL FULL IS 5 CFS.

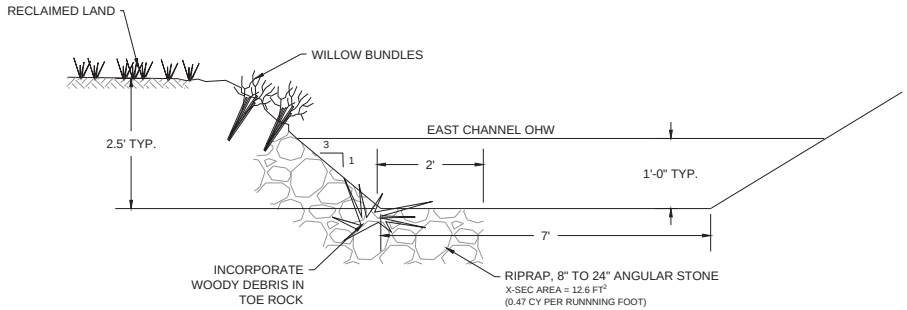
B EAST CHANNEL ENTRANCE SECTION
B 1 2
SCALE: N.T.S.



3 LAND RECLAMATION TREATMENT
3 1 2
SCALE: N.T.S.



2 BANK TREATMENT - MAIN RIVER
2 1 2
SCALE: N.T.S.



4 BANK TREATMENT - SOUTH EDGE OF RECLAMATION
4 1 2
SCALE: N.T.S.

REV	DESCRIPTION	DATE	APPD.	REFERENCE DRAWINGS
F	GEOGRID REMOVAL FOR CITY	9/16/19		
E	FOR FINAL PERMIT	7/19/19		
D	MODIFICATIONS TO CHANNEL	1/4/19		
C	ISSUE FOR BIDDING	10/18/18		
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(18 X 24) DWG ONLY

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(208) 736-8543

SWAN, SANDRA
RIVER RESTORATION PROJECT

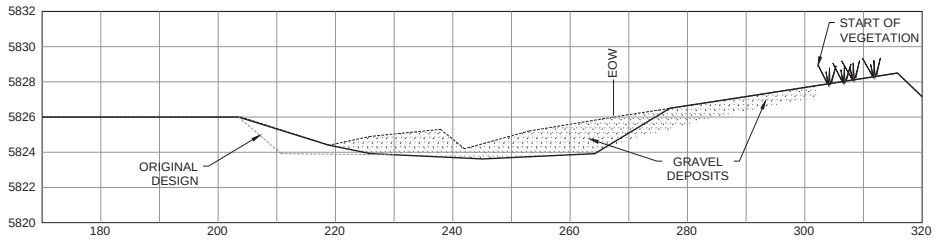
SECTIONS AND DETAILS

PROJECT # 538-17-2016

DWG # 2

REV F

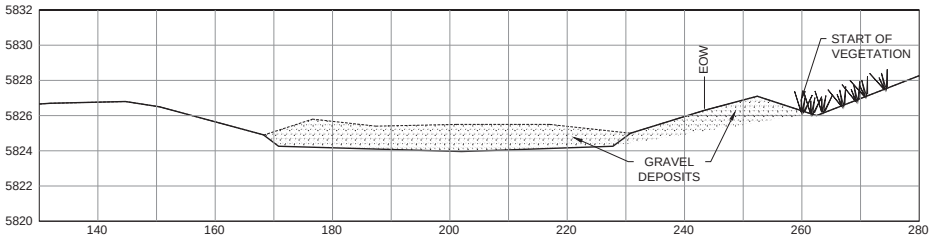
F:\Projects\Swan, Sandra\CAD - Phase 2\1436-02-2018-F.1-3.dwg



C.0 | 1 | 3

SECTION 100

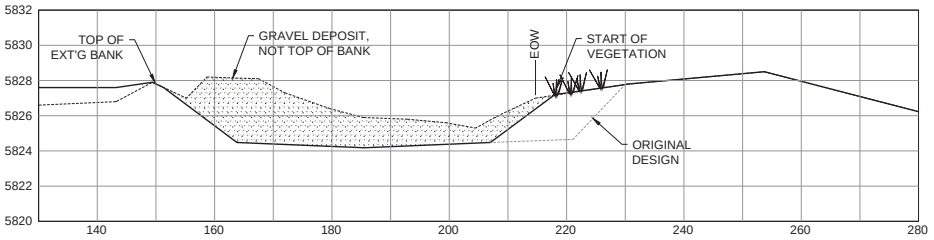
HORIZONTAL SCALE: 1" = 15'
VERTICAL SCALE: 1" = 5'



C.1 | 1 | 3

SECTION 101

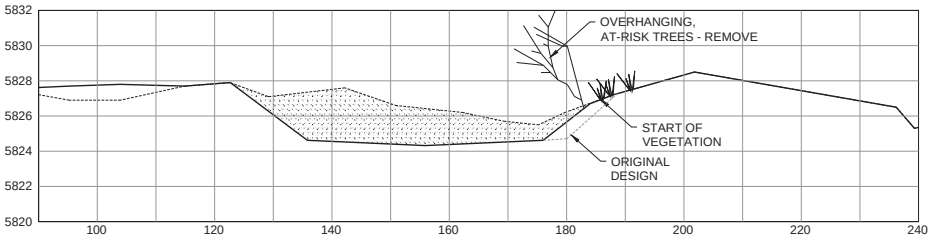
HORIZONTAL SCALE: 1" = 15'
VERTICAL SCALE: 1" = 5'



C.2 | 1 | 3

SECTION 102

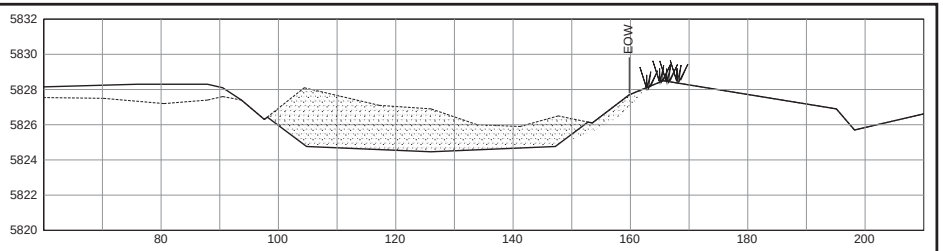
HORIZONTAL SCALE: 1" = 15'
VERTICAL SCALE: 1" = 5'



C.3 | 1 | 3

SECTION 103

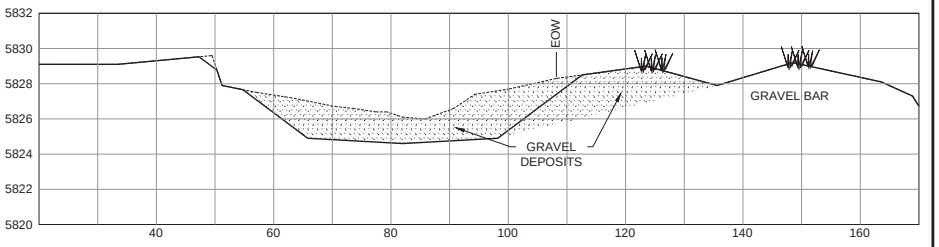
HORIZONTAL SCALE: 1" = 15'
VERTICAL SCALE: 1" = 5'



C.4 | 1 | 3

SECTION 104

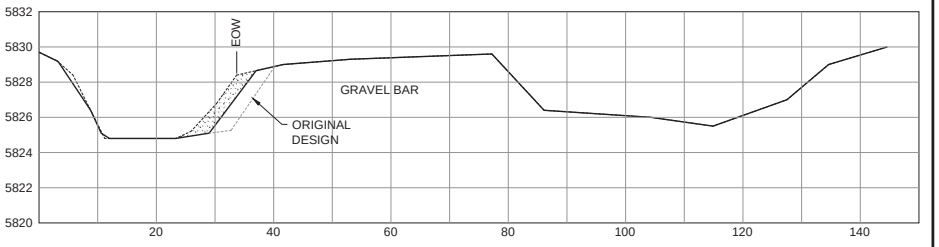
HORIZONTAL SCALE: 1" = 15'
VERTICAL SCALE: 1" = 5'



C.5 | 1 | 3

SECTION 105

HORIZONTAL SCALE: 1" = 15'
VERTICAL SCALE: 1" = 5'



C.6 | 1 | 3

SECTION 106

HORIZONTAL SCALE: 1" = 15'
VERTICAL SCALE: 1" = 5'

EXISTING CHANNEL - SURVEYED JULY 17, 2018
PROPOSED CHANNEL
EOW EDGE OF WATER AT TIME OF SURVEY

NOT FOR CONSTRUCTION

REV	DESCRIPTION	DATE	APPD.	REFERENCE DRAWINGS
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DESIGNED BY CGB | DRAFTED BY ICB

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(208) 736-8543

SWAN, SANDRA
RIVER RESTORATION PROJECT

CHANNEL CROSS-SECTIONS

PROJECT # 538-17-2016

DWG # 3

REV F

C. Draft River Restoration, Swan Residence, BYLA, dated September 16, 2019

REVEGETATION PLAN LEGEND

Symbol	Definition
—— — — ——	Property Line
— (Z1) —	ZONE 1 - NON RIPARIAN RECLAIMED LAND & DISTURBED AREAS
— (Z2) —	ZONE 2 - 25' RIPARIAN ZONE
— (Z3) —	ZONE 3 - BANK STABILIZATION
··················	ORDINARY HIGH WATER (OHW)
- - - - - - - -	25' RIPARIAN SETBACK

REVEGETATION PLAN - PLANTING SCHEDULE

ZONE 1 - Reclaimed Land Outside of 25' Riparian Zone	
SHRUBS: (3) Placed per every 1,000 Sq. Ft.	
Botanical Name	**Common Name**
Ribes aureum	Golden Currant
Cornus sericea	Red-osier dogwood
Alnus incana	River Alder
Rosa woodsi	Woods Rose
TREES: (5) Cottonwood Seedlings	
GRASSES	
Lawn	Match original Fine Fescue
ZONE 2- Riparian Zone w/ 25' of Big Wood River & East Channel	
SHRUBS: (12) Placed per every 1,000 Sq. Ft.	
Botanical Name	**Common Name**
Ribes aureum	Golden Currant
Cornus sericea	Red-osier dogwood
Alnus incana	River Alder
Rosa woodsi	Woods Rose
Riparian Grasses	
Botanical Name	**Common Name**
Festuca idahoensis	Idaho Fescue
Agropyron riparium	Streambank Wheatgrass
Festuca rubra	Creeping Red Fescue
Pseudoroegneria spicata	Bluebunch Wheatgrass
Lupinus sericeus	Silky Lupine
ZONE 3 - Bank Stabilization	
SHRUBS: Placed 5' apart maximum	
Botanical Name	**Common Name**
Salix boothi	Booth Willow
Salix geyeria	Geyer Willow
Salix lasiandra	Pacific Willow

PLAN NOTES:

1. THIS PLAN IS A GRAPHIC REPRESENTATION OF THE PROPOSED RESTORATION PLAN BY BROCKWAY ENGINEERING DATED SEPT. 16, 2019. APPROXIMATE SHRUB LOCATIONS SHOWN.
2. ALL NATIVE WOODY VEGETATION SHALL BE PLANTED WITHIN BANK STABILIZATION (ZONE 3) AT INTERVALS NO GREATER THAN 5 FEET SPACING STARTING FROM THE TOE OF SLOPE AND EXTENDING UP SLOPE ALONG THE TOP OF BANK.

N 0 16 32 FT

SCALE: 1" = 16'-0"

BYLA LANDSCAPE ARCHITECTS
323 Lewis | Ketchum, ID
(208) 726 5907 • (208) 720 0215
www.byla.us

No.	Description	Signature	Date

DRAFT
NOT FOR CONSTRUCTION

RIVER RESTORATION
SWAN RESIDENCE
ADDRESS

SITE OVERVIEW

09.16.2019

Date: 11.27.2018
Drawn By: TB, KR
Checked By: CG
File: FILE

Sheet No.
L1.0
#

E. Criteria for Evaluation of Applications (KMC 17.88.050.E)

Floodplain Design Review Requirements

1. EVALUATION STANDARDS: 17.88.050(E)

Compliant			Standards and Staff Comments	
Yes	No	N/A	Guideline	City Standards and *Staff Comments*
☐	☐	☐	17.88.050(E)1 FLOODPLAIN DEVELOPMENT/ WATERWAYS DESIGN REVIEW	Preservation or restoration of the inherent natural characteristics of the river and creeks and floodplain areas. Development does not alter river channel.
			Staff Comments	
☐	☐	☐	17.88.050(E)2	Preservation or enhancement of riparian vegetation and wildlife habitat, if any, along the stream bank and within the required minimum twenty five foot (25') setback or riparian zone. No construction activities, encroachment or other disturbance into the twenty five foot (25') riparian zone, including encroachment of below grade structures, shall be allowed at any time without written City approval per the terms of this chapter.
			Staff Comments	
☐	☐	☐	17.88.50(E)3	No development, other than development by the City of Ketchum or development required for emergency access, shall occur within the twenty five foot (25') riparian zone with the exception of approved stream stabilization work. The Administrator may approve access to property where no other primary access is available. Private pathways and staircases shall not lead into or through the riparian zone unless deemed necessary by the Administrator.
			Staff Comments	
☐	☐	☐	17.88.050(E)4	A landscape plan and time frame shall be provided to restore any vegetation within the twenty five foot (25') riparian zone that is degraded, not natural or which does not promote bank stability.
			Staff Comments	
☐	☐	☐	17.88.050(E)5	New or replacement planting and vegetation shall include plantings that are low growing and have dense root systems for the purpose of stabilizing stream banks and repairing damage previously done to riparian vegetation. Examples of such plantings include: red osier dogwood, common chokecherry, serviceberry, elderberry, river birch, skunk bush sumac, Beb's willow, Drummond's willow, little wild rose, gooseberry, and honeysuckle.
			Staff Comments	

Compliant			Standards and Staff Comments	
Yes	No	N/A	Guideline	City Standards and *Staff Comments*
☐	☐	☐	17.88.050(E)6	Landscaping and driveway plans to accommodate the function of the floodplain to allow for sheet flooding. Floodwater carrying capacity is not diminished by the proposal. Surface drainage is controlled and shall not adversely impact adjacent properties including driveways drained away from paved roadways. Culvert(s) under driveways may be required. Landscaping berms shall be designed to not dam or otherwise obstruct floodwaters or divert same onto roads or other public pathways.
			Staff Comments	
☐	☐	☐	17.88.050(E)7	Impacts of the development on aquatic life, recreation, or water quality upstream, downstream or across the stream are not adverse.
			Staff Comments	
☐	☐	☐	17.88.050(E)8	Building setback in excess of the minimum required along waterways is encouraged. An additional ten foot (10') building setback is encouraged to provide for yards, decks and patios outside the twenty five foot (25') riparian zone.
			Staff Comments	
☐	☐	☐	17.88.050(E)9	The top of the lowest floor of a building located in the one percent (1%) annual chance floodplain shall be a minimum of twenty four inches (24") above the base

Compliant			Standards and Staff Comments	
Yes	No	N/A	Guideline	City Standards and *Staff Comments*
				flood elevation of the subject property. (See section 17.88.060, figures 1 and 2 of this chapter.)
			Staff Comments	
☐	☐	☐	17.88.050(E)10	The backfill used around the foundation in the floodplain shall provide a reasonable transition to existing grade but shall not be used to fill the parcel to any greater extent. Compensatory storage shall be required for any fill placed within the floodplain. An LOMA-F shall be obtained prior to placement of any additional fill in the floodplain.
			Staff Comments	
☐	☐	☐	17.88.050(E)11	All new buildings shall be constructed on foundations that are approved by a licensed professional engineer.
			Staff Comments	
☐	☐	☐	17.88.050(E)12	Driveways shall comply with effective street standards; access for emergency vehicles has been adequately provided for.
			Staff Comments	
☐	☐	☐	17.88.050(E)13	Landscaping or revegetation shall conceal cuts and fills required for driveways and other elements of the development.
			Staff Comments	
☐	☐	☐	17.88.050(E)14	(Stream alteration.) The proposal is shown to be a permanent solution and creates a stable situation.
			Staff Comments	
☐	☐	☐	17.88.050(E)15	(Stream alteration.) No increase to the one percent (1%) annual chance floodplain upstream or downstream has been certified, with supporting calculations, by a registered Idaho hydraulic engineer.
			Staff Comments	
☐	☐	☐	17.88.050(E)16	(Stream alteration.) The recreational use of the stream including access along any and all public pedestrian/fisherman's easements and the aesthetic beauty is not obstructed or interfered with by the proposed work.
			Staff Comments	
☐	☐	☐	17.88.050(E)17	(Stream alteration.) Where development is proposed that impacts any wetland, first priority shall be to move development from the wetland area. Mitigation strategies shall be proposed at time of application that replace the impacted wetland area with a comparable amount and/or quality of new wetland area or riparian habitat improvement.
			Staff Comments	
☐	☐	☐	17.88.050(E)18	(Stream alteration.) Fish habitat shall be maintained or improved as a result of the work proposed.
			Staff Comments	
☐	☐	☐	17.88.060(E)19	(Stream alteration.) The proposed work shall not be in conflict with the local public interest, including, but not limited to, property values, fish and wildlife habitat, aquatic life, recreation and access to public lands and waters, aesthetic beauty of the stream and water quality.
			Staff Comments	
☐	☐	☐	17.88.060(E)20	(Stream alteration.) The work proposed is for the protection of the public health, safety and/or welfare such as public schools, sewage treatment plant, water and sewer distribution lines and bridges providing particularly limited or sole access to areas of habitation.
			Staff Comments	

F. Manufacturers “Design and Installation Guidelines for Erosion Control” manual

Design and Installation Guidelines for Erosion Control

GEO products

ENVIROGRID®

Geo Products, LLC
12626 North Houston Rosslyn Road
Houston, TX 77086
Phone: 281.820.5493
Fax: 281.820.5499
www.geoproducts.org

Erosion Control Application Overview

Many variables affect the installation and performance of EnviroGrid® confinement systems, including slope grade, subsurface stability, infill material, rainfall and artificial watering conditions, hydraulic characteristics of ground water flow and sub base anchoring quality. Due to the large number of factors, it is difficult to apply exact parameters to individual applications without depending on engineering, design and environmental inputs of on-site professionals.

VARIOUS FILL FOR ENVIROGRID® EROSION CONTROL

1. **Granular**
   - Reduces hydraulic energy, limiting forces within cells or under cells.
   - Directs flow at the surface of the cell, eliminating flanking and undercutting.
   - Controls individual particle movement caused by gravity and water flow.
   - Results in a flexible and durable system.

2. **Vegetation**
   - Reduces hydraulic energy, limiting forces within cells or under cells.
   - Increases natural resistance and protects root system.
   - Directs water flow over the top, rather than through the panel.
   - Prevents gutting and rills.
   - Helps reduce moisture loss.

3. **Concrete**
   - Controls undercutting by allowing cells to conform to sub grade.
   - Acts as a series of expansion joints, providing a flexible form.
   - Allows for vent structures where needed.
   - Provides stability for steep slopes and for continuous flow channels.

Infill Material Selection

- Topsoil and Vegetation: Steep slopes, berms, levees, chutes, aprons and spillways.
- Sand and Granular Fill: Suitable on gradual slopes.
- Aggregate: Channels, slopes, except for severe grades, moderate sheet flow.
- Structural/Growth Fill: Vegetated slopes that experience traffic loads (See below*).
- Concrete: Around bridges, severe slopes, high flow rate channels, spillways and chutes.

*The *EnviroGrid® Structural/Growth Infill* (Infill) material shall be composed of an aggregate and growing medium blend meeting the following requirements.

1. Aggregate
    1. The aggregate shall be durable, with 95+% of its fascia split or broken
    2. The aggregate shall meet the following gradation and void ratio requirements

	Cell Depth	Particle Range	D_{50}	Void Ratio
EnviroGrid® EGA20	4”	0.5” – 1.25”	0.75” - 1.0”	≥ 30%
	6”	0.5” – 2”	0.75” – 1.25”	≥ 30%
	8”	0.5” – 2”	0.75” – 1.25”	≥ 30%
EnviroGrid® EGA30	6”	0.5” – 2”	0.75” – 1.25”	≥ 30%
	8”	0.5” – 2”	0.75” – 1.25”	≥ 30%

2. Growing Medium
    1. The growing medium shall be suitable to support the specified vegetation.
    2. The growing medium shall be well-drained, allowing infiltrating water to pass through to an underlying drainage layer/system or to a well-drained subgrade layer.

3. The growing medium shall be screened to remove sticks, soil clods and other deleterious materials which prevent proper blending with the aggregate and placement with the EnviroGrid® product.

3. Blended Aggregate and Growing Medium (Infill)
    1. The Aggregate and Growing Medium shall be pre-blended to achieve a homogenous mixture (Infill) prior to placement into the EnviroGrid®.
    2. The bulked (uncompacted) volume of Growing Medium shall be 95% - 100% of the void volume within the compacted aggregate.
4. The Infill material shall be placed into the EnviroGrid® material and compacted to a minimum of 95% Standard Proctor Density or per the Engineer's requirements.
    1. Placement of the bulked, blended Infill should result in an 'overfill' of the EnviroGrid® product. Typically, a 0.5" – 0.75" overfill is needed for 4" deep EnviroGrid® products. A 0.75" to 1.5" overfill is needed for the 6" and 8" material.
    2. Compaction shall result in the Infill being level with or slightly above the cell walls of the EnviroGrid® product.
    3. Operation of compaction equipment directly on the cell walls of the EnviroGrid® product is prohibited.

Applications

SLOPES

Design of EnviroGrid® cellular confinement systems for slopes requires analysis of several site characteristics. The length, height and angle of the slope and the failure angle of existing fill on the slope are important factors in determining the appropriate cell depth and anchoring design. Minor factors also include snow load and the weight of chosen fill material.

EnviroGrid® improves the performance of vegetated slopes by reinforcing root systems and directing hydraulic flows over the top of cells, with the cells acting as a series of check dams, thereby preventing formation of rills and gullies.

EnviroGrid® improves the performance of granular filled slopes by controlling the migration of fills that would otherwise be initiated by hydraulic and gravitational forces. This is accomplished by dissipating hydraulic energy throughout and underneath cells and by confinement of fill materials within cells.

CHANNELS

EnviroGrid® cellular confinement systems offer a large array of methods for solving difficult situations with channel bottoms and slopes where minimal to severe erosive forces are at work, with either intermittent or continuous flows.

Cellular confinement allows for the use of various types of infill, including soil with vegetation, aggregate, concrete or combination thereof, for unique and aesthetic applications.

***Vegetative Soil* Infilled Channel**

Confined vegetative soil performs exceptionally well in applications with low to moderate flows. EnviroGrid® Cellular confinement enhances the performance of vegetation through reinforcing root zones and directing flows over the top cells; thereby increasing the shear resistance of the fill and providing a finished site that is aesthetically superior when compared to conventional methods.

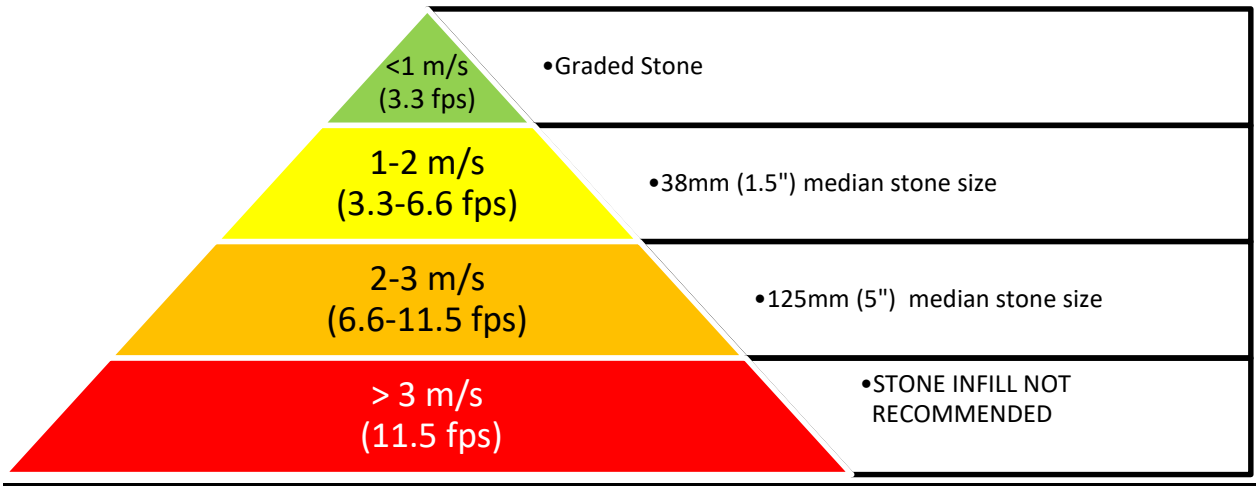
<u>Soil infill with grass cover:</u>

- Peak flow velocity less than 6 m/s (20 fps) and duration of peak flow less than 24 hours.
- Peak flow velocity less than 4.5 m/s (15 fps) and duration of peak flow less than 48 hours.
- Channel side slopes above high water level.

***Aggregate* Infilled Channel**

Aggregate performs well, allowing the use of different sizes for variances in flow velocities encountered from site to site. This provides an aesthetically pleasing and cost effective alternative to large rip rap or hard armoring by confining and improving the performance of smaller diameter, less costly aggregate.

Peak Flow Velocities with Stone Infill and recommended sizes:

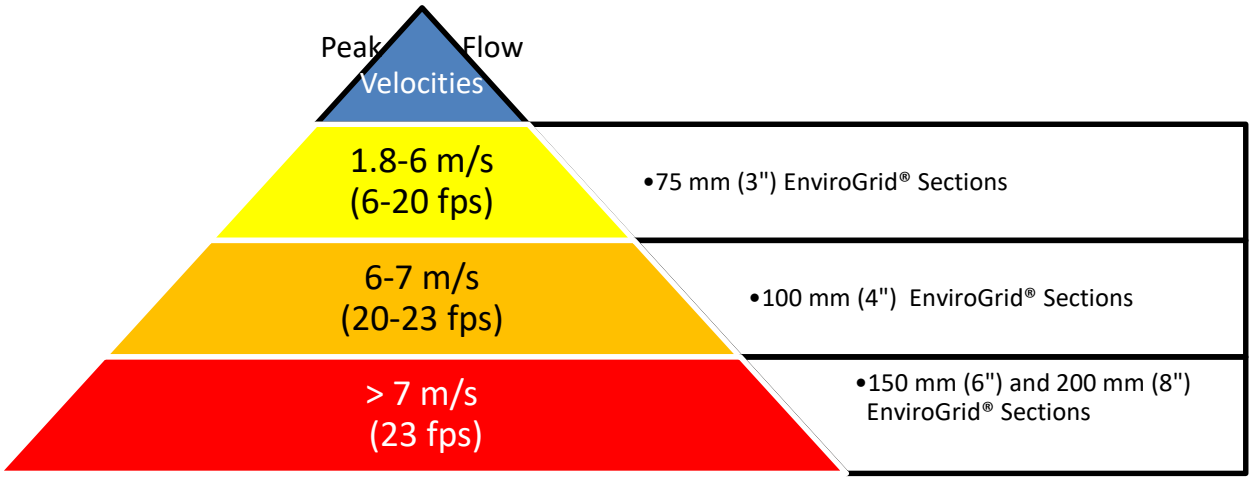


***Concrete* Infilled Channel**

The concrete filled EnviroGrid® cellular confinement system is a cost effective alternative to traditional installed concrete lined channels. The flexible nature of the concrete filled cellular confinement system permits conformance with subgrade movement without the potential cracking and undermining associated with poured-in-place concrete slabs. Installation costs are dramatically reduced through elimination of costly forms and other construction techniques typically related to concrete channel lining.

In areas with limited easements, stacked EnviroGrid® cellular confinement panels along channels performs as a retaining wall. This allows the use of vegetative, granular or concrete fills in the outer cells in order to create steeper slopes and to increase resistance to higher flow rates.

<u>Concrete Infill Peak Flow Velocities and recommended EnviroGrid® Section depths:</u>

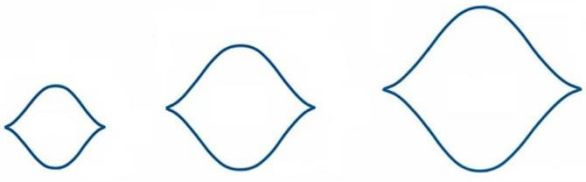


NOTE: Anchor requirements are a function of depth of peak flow, bed slope gradient and self-weight of the lining system. The Project Engineer should base the design on the project specific information.

SUITABLE CELL DEPTHS

In most erosion control applications, load bearing is not a major consideration. Therefore, the depth of the cell is generally determined by:

- Slope Grade
- Size and weight of infill
- Outside environmental factors
- Economics
- Required root zone for vegetation



RECOMMENDED CELL SIZE AND DEPTH FOR VARIOUS SLOPE CONDITIONS

Below is a table that you can utilize to determine the recommended cell depth and cell size for different slope scenarios. Please contact Geo Products for any final recommendations based on specific project parameters.

Slope Degree															
0.5 to 1	**60°**	6"	6"	6"	6"	6"	6"	6"	6"	6"	6"	6"	6"	6"	6"	EGA20
1 to 1.5	**55°**	6"	6"	6"	6"	6"	6"	6"	6"	4"	4"	4"	4"	4"	4"	
1 to 1	**45°**	6"	6"	6"	6"	6"	6"	6"	6"	6"	6"	6"	4"	4"	4"	EGA30
1.5 to 1	**35°**	6"	6"	6"	6"	6"	4"	4"	4"	4"	4"	4"	3"	3"	3"	
2 to 1	**25°**	6"	4"	4"	4"	4"	4"	4"	3"	3"	3"	3"	3"	3"	3"	
3 to 1	**20°**	4"	4"	4"	4"	4"	4"	3"	3"	3"	3"	3"	3"	3"	3"	
4 to 1	**15°**	6"	6"	4"	4"	4"	4"	4"	4"	3"	3"	3"	3"	3"	3"	EGA40
5 to 1	**10°**	6"	4"	4"	4"	4"	4"	4"	3"	3"	3"	3"	3"	3"	3"	
		14°	**16°**	**18°**	**20°**	**22°**	**24°**	**26°**	**28°**	**30°**	**32°**	**34°**	**36°**	**38°**	**40°**	
		Wet Clay, Water-filled Sand		*Silty Clay*		*Clay*	*Mixture of Inorganic Silt & Clay*		*Silty Sand*		*Crushed Stone, Dry Sand*		*Decomposed Granite, Limestone*		*Wet Sand*	

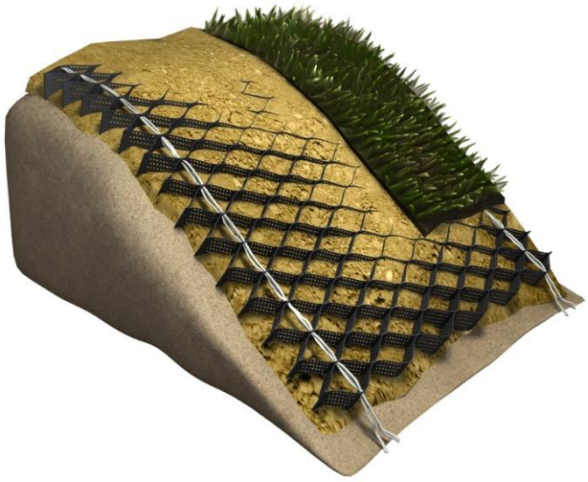
Lowest Angle of Internal Friction ϕ for infill material

*Metric Conversions: 6” = 150mm, 4” = 100mm, 3” = 75mm

Geotextiles

Whether to use a geotextile under the EnviroGrid® is dependent on the subgrade and fill material. When the infill and subgrade are different, or if the subgrade is very soft or wet, a geotextile can provide a useful separation function by keeping the infill from migrating out from under the geocells. A geotextile is also beneficial in protecting the subgrade under the EnviroGrid® system. However, using a geotextile can reduce significantly the friction along the plane at the bottom of the EnviroGrid® system, thus increasing the net sliding force. Thus the decision whether or not to use a geotextile should be made carefully, after evaluating the benefits and costs.

Anchoring



Proper anchoring of the EnviroGrid® to a slope is critical to how well the product performs. Anchors should be left in place after installation. The number and type of anchors is determined by the following:

- Subgrade density
- Weight and type of infill
- Length of slope
- Slope grade
- Environmental or external conditions, such as snow.
- Angle of internal friction (ϕ) of the fill material and of the slope soil (only the smaller of the two will be used)
- Height of EnviroGrid®
- Presence of geomembrane liner
- Presence of non-woven geotextile
- Factors of safety

Before selecting an anchoring method, it is first necessary to calculate the net sliding force (NSF) or the force which would have to be overcome to keep the EnviroGrid® from sliding down the slope. If the NSF is negative, then the friction force between the EnviroGrid® and the slope is sufficient to hold the system in place. The following table shows some examples of NSF calculation:

$$NSF = [(H \times L \times \gamma) + (L \times S)] \times [\sin W - (\cos W \times \tan \phi)]$$

NSF kN/m*	H mm	L m	γ kN/m³	S kN/ m²	W SLOPE	ϕ DEGREES
0.8	100	6.1	19.6	1.9	1.75 to 1 (29.7°)	28° (silty sand)
5.5	150	33.0	19.6	1.9	1.75 to 1 (29.7°)	28° (silty sand)
-13.1**	100	30.5	19.6	1.9	2.00 to 1 (26.6°)	32°(crushed stone)

NSF- Net Sliding Force
γ- Unit Weight of Fill
H- Height of Cell
S- Snow Load
L- Length of Slope
W- Slope Inclination (H to V)

ϕ- Lowest Angle of Internal Friction of Soil

* Pounds per foot measured parallel to top of slope

ENVIROCLIPS TWIST ANCHORS

Staking or pinning EnviroGrid® to a slope is the common anchoring method used if there is no geomembrane liner present and if the soil has adequate strength to retain the anchor pins. The EnviroClips are the preferred type of pin.

Features and benefits of the EnviroClips

- Quick and easy to install with an electric drill and custom chuck - 5 times faster installation process compared to standard stakes
- Eliminates time, labor, and safety concerns from carrying and hammering heavy rebar on steepened slopes
- Clips into the perforated side walls of the EnviroGrid
- Superior performance when compared to traditional rebar J-hooks, up to 9 times the pull out force of J-hooks
- Can be installed to full depth without damaging or rising above the EnviroGrid wall
- Actively anchors EnviroGrid against natural and sliding forces eliminating the need for tendons and expensive dead man anchor trench and pipe

Typical detail drawings of pin locations are available. If no engineer recommendations are provided, use one EnviroClip per square meter/yard of EnviroGrid®.

ANCHORING METHOD

Given the resulting net sliding force (NSF) for two of the cases in the previous table the next step is to decide how to anchor the EnviroGrid®. For the situation where NSF = 0.8 kN/m, two common methods of anchoring of the EnviroGrid® are to toe it in or to stake it to the slope. For the situation where NSF = 5.1 kN/m, the EnviroGrid® could be supported by earth anchors with tendons.

Anchor Trench

Using the appropriate equation

$$L \times H = \frac{0.8 \times 2}{19.6 \times \tan 28^\circ} = 0.15 \text{ sq. m}$$

A practical combination would be to bury the top edge of the EnviroGrid® 0.3 m deep and 0.5 m back. Another practical combination would be to let L be 0.75 m and H be 0.2 m.

Stakes

0.8 kN/m is equivalent to 0.8 x 2.56 = 2.0 kN for the 2.56 m wide panel. Using a factor of safety of 2.0 and a stake pull-out capacity of 0.27 kN*:

$$\frac{2.0 \times 2.0}{0.27} = 14.8 \text{ “J” Hooks, use 15 stakes per 2.56 m wide width}$$

If the tendons are tied to earth anchors, using the same number of anchors as tendons, an additional factor safety of 1.25 to account for uncertainties in the subgrade soil:

- Stake pull-out capacity will depend upon several factors, including on-site soil conditions at their weakest, and the care with which the stakes are driven into the soil. Thus the local engineer must evaluate and make a judgment as to what value should be used.

Tendons

5.5 kN/m is equivalent to 5.5 x 2.56 = 14.1 kN for the 2.56 m wide panel. Using a factor safety of 3.0 and a tendon design strength of 13.0 kN:

$$\frac{14.1 \times 3.0}{13.0} = 3.25 \text{ tendons, use 4 tendons per 2.56 m panel width}$$

STAPLES

Adjacent sections of EnviroGrid® must be joined together with staples. Staples are normally attached using a pneumatic staple gun with industrial grade staples. The staples are attached through each set of adjoining cells. The number of recommended staples per various cell heights is listed in the table below.

Number of Staples Required	
Cell Height	**# of Staples**
3" (76 mm)	3
4" (102 mm)	3
6" (152 mm)	4
8" (203 mm)	5

TENDONS AND RESTRAINT PINS

Tendons and restraint pins are employed on steep slopes where additional support is needed, or where the use of J-Hooks is prohibited (rock base, geomembrane liner). They are also commonly used when more than one section of EnviroGrid® is needed to cover the slope from top to bottom.

The three important characteristics of tendons are strength, durability and resistance to creep. Tendons usually consist of high strength polyester webbing or cord. The design load and spacing of the tendons is determined by the force to be supported. At the lowest section of EnviroGrid®, the tendons can be tied to a J-Hook to avoid stress concentrations. The number of tendons required should be determined by the project engineer. Please contact Geo Products if assistance is required.

Installation Procedures

Prepare the site by removing all vegetative cover, debris and any unacceptable soils from the area where the EnviroGrid® cellular confinement system is to be placed. Replace any removed soils with acceptable materials and complete all earthwork, including going in trenches when required for slopes or channel lining applications, in accordance with the job specifications.

If geotextile is required by the job specifications, installation should be accomplished in accordance with the manufacturer's recommendations.

EnviroGrid® should always be placed beyond the crest of the slope to prevent surface water from undermining the EnviroGrid®. A string or chalk line may be used to align staking locations and borders. **DO NOT EXPAND THE PANEL(S) DOWN THE SLOPE AT THIS TIME.**

***For Projects over Geomembranes**: Make sure that the geomembrane or other geosynthetic material has been installed per manufacturer's instructions and that all earthwork has been prepared, including anchor trenches when required for slopes or channel lining applications, in accordance with the job specifications.*

Measure the total length (down the slope) of the area to be covered. Calculate how many cells will be required to cover the entire length. The chart below will help in this calculation:

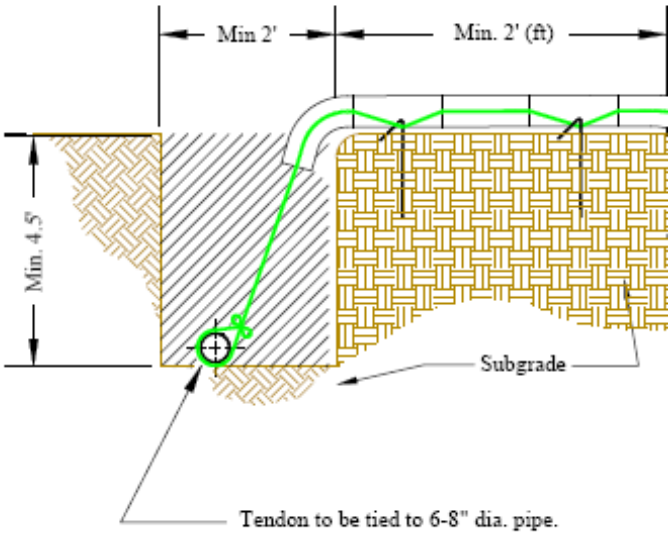
Expanded Cell and Panel Sizes				
All Standard Panels are 2.56 m(8.4') Wide and 29 Cells Long				
Product	Cells per Width	Cell Width	Cell Length	Panel Length
EGA20	10	0.26m (0.85')	0.22m (0.74')	6.52 m (21.4')
EGA30	8	0.32m (1.05')	0.29m (0.95')	8.35 m (27.4')
EGA40	5	0.51m (1.67')	0.48m (1.56')	13.72 m (45')

If the total length to be covered is less than one single standard Panel Length, you may cut off the extra cells or simply keep the additional cells collapsed.

If the length to be covered is more than one single standard Panel Length, multiple panels will need to be joined together using staples. For example: If the slope is 100' long, and you are using EGA30 Panels, you will need 3 full panels (3 x 27.4' = 82.2'), plus 19 cells of an additional panel ($\frac{(100' - 82.2')}{0.95'} = 18.7\ cells$ [round up to 19 cells]). Staple the panels together BEFORE expanding the panel down the slope. Please see the table on page 11 for recommended number of staples per cell.

Anchor Trench

The upper edge of the EnviroGrid® should be buried in an anchor trench to prevent flow underneath. This also serves to anchor the EnviroGrid® to the top of the slope. This method takes advantage of the weight of the soil on top of the buried cells. The following equation can be used to calculate the required length and height of the trench to resist the sliding force:

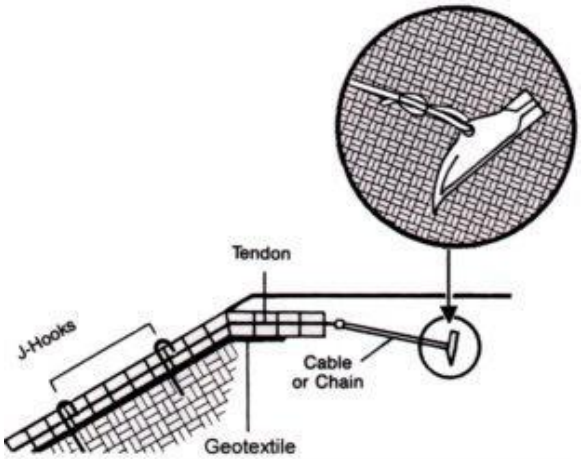


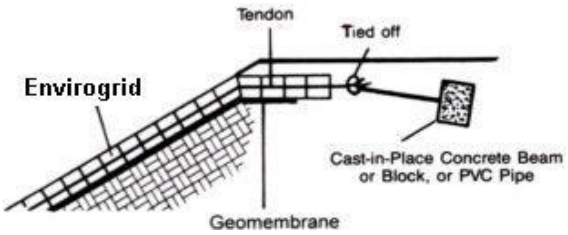
$$((d-a)a+\frac{(d-a)^2}{2})*\gamma = NSF^a * FS$$

d = Depth of Trench
a = Diameter of Anchoring Pipe
γ= Unit weight of the backfill material in the trench
NSF^a = Net Sliding force per m
FS = Factor of Safety with respect to Sliding

Installation Using Tendons

If the EnviroGrid® does not already have holes for tendons, drill a 16 mm to 25mm (5/8" to 1") hole through all cell walls before expanding the EnviroGrid® sections. Measure and cut tendons to desired length (include slope length, horizontal component on top of slope, and depth of anchor trench) adding approximately 15% for tying around restraint pins and anchor pipe. Even if multiple panels of EnviroGrid® are required, a single tendon should run the entire length of the slope. Tie the tendons to a supporting structure beyond the crest of the slope. This supporting structure may be a length of high-strength PVC pipe, a concrete beam, or set of concrete blocks placed in an anchor trench. An alternative system may consist of harpoon like earth anchors.

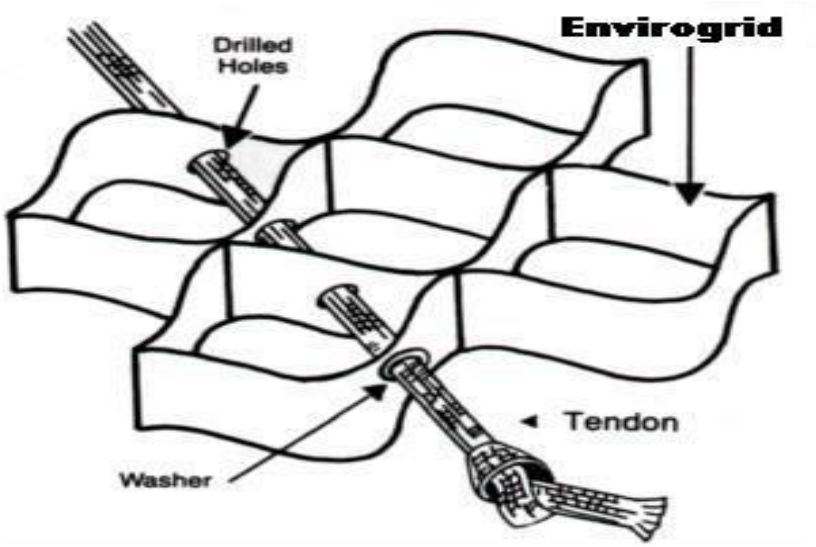




At the top of the slope, thread tendons through the holes in the unexpanded EnviroGrid® sections.

Expand the panel(s) of EnviroGrid® down the slope taking care that the tendons do not come out of the holes. EnviroGrid® sections should be stretched past the designed length then allowed to settle back to the designed length.

Tie the tendons, in tension, to a J-Hook, restraint pin, or the cell wall on the downhill side of the last cell. The use of these restraining devices helps to transfer the load from the EnviroGrid® to the tendons. These devices should be made from corrosion resistant materials such as galvanized steel, high strength plastic, etc.



Place J-Hooks in cells where needed to hold appropriate shape for filling.

Adjoining EnviroGrid® sections must be level and flush with each other. Overlap the sides of the EnviroGrid® sections and butt the ends together. Secure adjoining sections to each other using a pneumatic stapler or other means as required by the job application.

Install the balance of the stakes or "J" hooks. The amount of anchoring required will vary by job site conditions and many other factors. Follow the project engineer's job specifications for location and number of anchors (J-Hooks) required. See page 13 for a guideline concerning anchors and design. The drawings below provide a recommended procedure for installing anchor pins with tendons.

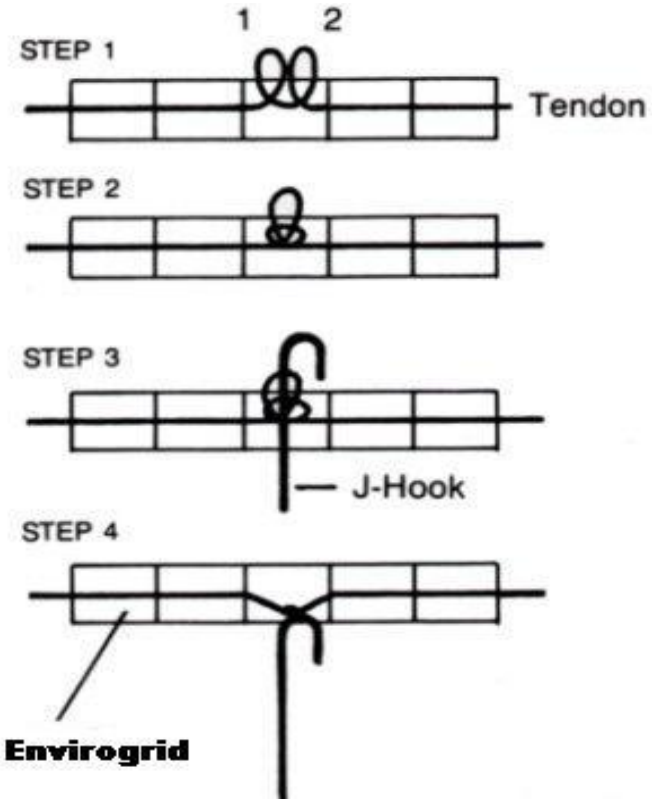
ANCHOR PIN INSTALLATION WITH TENDONS

STEP 1: Make 2 loops in the tendon.

STEP 2: Pull loop 1 partially through loop 2.

STEP 3: Insert the specified J-hook anchor through loop 1 and drive J-hook into the ground until the top of hook is level with the top of the EnviroGrid® section.

STEP 4: Pull both ends of tendon to close the loop and drive the J-hook until the top of it is flush with ground surface.



When the EnviroGrid® has been properly laid in place, the system should be filled using the materials specified in the job specifications.

To prevent possible damage to the system, limit the drop height of the infill to no more than 1m (40").

Infill should be delivered to the EnviroGrid® from the top of the slope or channel to the base using a front-end loader, backhoe, bucket excavator or conveyor.

When using sand, granular or topsoil fills, overfill the EnviroGrid® sections by 25mm (1") to 50 mm (2") to allow for settling and compaction.

Sand and granular fills should then be blade compacted to the top of the cells. Topsoil fills should be compacted with the loader or backhoe bucket or with a tamper plate.

Concrete fills should be manually raked and machine finished.

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