How to Map Open Space Preservation for Community Rating System Credit

GIS Workflow

NOAA Office for Coastal Management

Overview

The Federal Emergency Management Agency’s Community Rating System (CRS) is a program that credits communities’ efforts to reduce their flood risk with discounts on flood insurance premiums for its policyholders. The CRS uses credit to determine the amount of a community’s insurance discount. A key way communities can earn CRS credits is to preserve floodplains through conservation of open space and implementation of land use policies that encourage development away from wetlands, dunes, and other naturally protective features.

This GIS workflow document is a companion to NOAA’s training resource, *How to Map Open Space for Community Rating System Credit*. It provides a step-by-step approach to help GIS practitioners calculate credit for open space under CRS Activity 420: Open Space Preservation (OSP) in areas that are already protected, and to identify places where additional credit could be earned through future preservation efforts. The steps draw from guidance in the 2017 CRS Coordinator’s Manual, produced by the Federal Emergency Management Agency (FEMA), and reference related elements in other CRS activities.

This document is geared towards GIS professionals who are assisting a community’s CRS coordinator or local planners with the mapping and calculations needed to earn open space activities under Activity 420. The GIS workflow focuses on the calculations required to determine

- OSP credit for parcels that are kept free of development through local regulations or land ownership; and
- additional credit for parcels of open space that are
  - protected by deed restriction (DR), and
  - have been preserved in or restored as natural functions open space (NFOS).

These credits—OSP, DR, NFOS—are based on the ratio of preserved open space in the regulatory floodplain to the area of the impact-adjusted special flood hazard area (aSFHA). The steps draw from guidance outlined under Activity 420 of the CRS Coordinators Manual to help communities document possible credit. *All points must be verified and are determined by FEMA before they are credited.*

NOTE: This document does not cover mapping or calculations needed to earn credit under CRS Activity
420 for special-flood hazard open space (SHOS), coastal erosion open space (CEOS), open space incentives (OSI), low-density zoning (LZ), or natural shoreline protection (NSP).

Also important is collaborating with the various municipal departments and local organizations that acquire and maintain open space in your community and may be able to obtain or locate regulatory documents (e.g., ordinance letter) for a particular parcel, which may be needed for certain open-space credit. These groups can include the parks department, land use or planning department, floodplain managers, local and state land trusts, and private property owners. See the CRS how-to, “Before You Get Started.”

Technical requirements: The workflow assumes that basic tasks, such as creating a new field in an attribute table of a shapefile, can be completed without guidance. This workflow was developed using ESRI ArcMap 10.5 and references specific geoprocessing tools, but many of these tools are available in most open-source GIS software.
GIS Goal: Generate a spatial layer that lists parcels with eligible open space preservation (OSP) areas within the community’s special flood hazard area (SFHA) or regulatory floodplain, calculate potential OSP credit, and create an impact adjustment map.¹

<table>
<thead>
<tr>
<th>Mapping Objective</th>
<th>Credit Criteria</th>
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</table>
| Step 1. Calculate the community’s impact-adjusted special flood hazard area (SFHA). | ● Acreage of special flood hazard area (SFHA) with water bodies and federal lands removed to calculate the adjusted SFHA (aSFHA)  
● aSFHA is the denominator in impact adjustment ratios.                                   |
| Step 2. Identify lands that may qualify for open space preservation credit.        | Parcels that contain potentially qualifying “preserved” open space or development regulations that prohibit buildings and filling |
| Step 3. Exclude areas that do not qualify for open space credit.                  | Impervious areas, parcels that obstruct flood flows or aggravate flooding, and other ineligible lands                                          |
| Step 4. Calculate possible credit for the community’s preserved open space.       | ● Ratio (rOSP) of preserved open space areas (aOSP) to the adjusted SFHA area (aSFHA), multiplied by the maximum number of points  
● rOSP = aOSP/aSFHA (x 1,450 points)                                                   |
| Step 5. Determine whether preserved open space parcels qualify for “extra credit.” | Parcels with deed restrictions (DR) or qualify for natural functions open space (NFOS)                                                       |
| Step 6. Gather supporting documentation for each parcel or area to submit to FEMA’s ISO/CRS Specialist. | List of eligible parcels showing the area that qualifies for open space credit on an impact adjustment map, documentation of open space status and “extra credit” |
| Step 7. (Optional) Identify opportunities to earn more open space credit for areas that may benefit from future protection. | Unprotected areas and lands likely to earn open space preservation credit if protected in the future² |

¹ The mapping objectives and spatial criteria help determine what GIS data sets are needed to represent the spatial features required to identify parcels with eligible open space.

² Similar to Step 5, Step 7 is an “extra” step that goes beyond requirements for determining OSP credit and will not provide CRS credit on its own.
GIS Data Checklist: Below is a list of geospatial information you may need to complete CRS Activity 420 (OSP) and suggestions on where you may find the relevant information. *All data sets should be clipped to the community boundary and projected to state plane coordinate system.*

<table>
<thead>
<tr>
<th>GIS Data Set</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Special flood hazard area (SFHA)^3</td>
<td>FEMA Map Services Center</td>
</tr>
<tr>
<td>Community boundary</td>
<td>State, county/city planning department</td>
</tr>
</tbody>
</table>
| Parcels | – State/county/city planning department  
| | – Tax assessor’s office |
| Land use^4 | County/city planning department |
| Federal lands | USGS Protected Areas of the U.S Database (PAD-US) |
| Hydrology/open water^5 | National Hydrography Dataset (NHD) |
| Impervious surfaces (choose one) | High-resolution land cover from planning department or NOAA Coastal Change Analysis Program (C-CAP), if available |
| | High-resolution imagery from National Agriculture Imagery Program (NAIP) or local ortho imagery |
| | Percent Impervious from USGS National Land Cover Database (NLCD) |
| Protected areas^6 | – USGS Protected Areas of the U.S Database (PAD-US)  
| | – USDA NRCS database  
| | – Trust for Public Land’s Conservation Almanac  
| | – Local land/conservation trusts or county/city planning department |
| Conservation easements | – National Conservation Easement Database (NCED)  
| | – USDA NRCS database |
| Public open space^7 | County/city planning department |
| Development regulations^8 | County/city planning department |
| Natural land cover | NOAA Coastal Change Analysis Program (C-CAP) |

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^3 Regulated floodplain areas outside of the SFHA that are mapped and documented (as described in Activity 410: Floodplain Mapping) can be included here as well.

^4 Land use layer is necessary if not an attribute in the parcel database.

^5 Lakes, bays, and large rivers

^6 Designated reserves and managed open space or parks

^7 Publicly owned natural areas within the community

^8 Areas covered by community land development regulations (e.g., shoreline, dune or wetland setbacks, or protective ordinances in the floodplain)
## GIS Workflow: Open Space Preservation
### Community Rating System Credit

<table>
<thead>
<tr>
<th>Open Space Preservation (OSP) “Extra Credit” Elements</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Deed restrictions</strong></td>
<td>Parcels with field in attribute table for deeds</td>
</tr>
<tr>
<td></td>
<td>– Local land/conservation trusts</td>
</tr>
<tr>
<td></td>
<td>– County/city planning department</td>
</tr>
<tr>
<td><strong>Natural functions open space (NFOS)</strong></td>
<td>Undeveloped areas in their natural state</td>
</tr>
<tr>
<td></td>
<td>– USGS PAD-US</td>
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<tr>
<td></td>
<td>– USFWS National Wetlands Inventory</td>
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<tr>
<td></td>
<td>– State natural resource agency</td>
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<tr>
<td><strong>Critical habitat for threatened or endangered species (federal- and state-listed species)</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>– State natural resource agency</td>
</tr>
<tr>
<td></td>
<td>– State natural heritage program</td>
</tr>
<tr>
<td><strong>Conservation corridors (e.g. greenways or wildlife corridors)</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>– State natural resource agency</td>
</tr>
<tr>
<td></td>
<td>– County/city planning department</td>
</tr>
</tbody>
</table>
Step 1. Calculate the Community’s Special Flood Hazard Area.

Overview:
The community’s special flood hazard area (SFHA) is a key piece of information to calculate most open space credit. The SFHA is also known as the “100-year floodplain.” FEMA maps this area on the community’s Flood Insurance Rate Map (FIRM). A community can exclude some areas within the SFHA where the community has no regulatory control to calculate the impact adjusted SFHA, or aSFHA. This step will remove all acreage that is ineligible for CRS credit to reduce the size of the denominator in the aSFHA calculation, thus increasing the potential for open space credit.\(^9\) The objectives of Step 1 are to

Calculate the acreage of the special flood hazard area (SFHA) shown on the community’s Flood Insurance Rate Map (FIRM), as mapped by FEMA.

Adjust the total area of the SFHA by subtracting areas the community does not regulate, including

- **Open waters.** Lakes, bays and rivers larger than 10 acres or for reaches of a river that are wider on average than 500 feet from bank to bank.
- **Federally owned or restricted lands.** Areas larger than 10 acres that are owned either by the federal government (e.g., military installations or national parks) or where the federal government prohibits development.
- **Other areas the community does not regulate.** The community can opt to include or exclude non-federal areas it does not have authority to regulate, such as state lands, tribal lands, or lands owned by another community. Check with your community’s CRS coordinator or ISO/CRS specialist to identify which, if any, non-federal areas to exclude.\(^10\)

If applicable, map the acreage of the floodplain outside the SFHA where the community enforces development regulations outside the SFHA that are similar to those enforced for new development within the SFHA. The total area of the SFHA plus the acreage where the community enforces regulations similar to those enforced in the SFHA is called the regulatory floodplain and generally includes the “500 year floodplain” or other areas that the community has determined to be at risk. The community must map the area on its impact adjustment map and document its floodplain management regulations, per activity CRS Activity 410 (Floodplain Mapping).

**NOTE:** The SFHA is the focus of this “How to”, but a community may use the regulatory floodplain as a base map for open space preservation credit and should use this layer as they identify lands that may qualify for OSP credit in Step 2.

Input GIS Data Sets:

- Special Floodplain Hazard Area (SFHA)
- Community Boundary

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\(^9\) Areas excluded in the SFHA for Activity 420 will have to be excluded for other CRS activities as well.

\(^10\) Other areas the community does not regulate must be included for all CRS activities.
GIS Workflow: Open Space Preservation
Community Rating System Credit

- Federal Lands
- Hydrology

**Output GIS Layer:** The impact adjusted SFHA, or aSFHA. The area of the aSFHA is the denominator for impact adjustment ratios.

**GIS Analysis:**

1. Open the Community Boundary and SFHA layers.
2. In the attribute table of SFHA, Select by Attributes the SFHA flood zones 11 where the field “SFHA_TF” = “T”.
3. With the “SFHA_TF” = “T” features selected, Clip the SFHA to the Community Boundary to determine the special flood hazard area inside the community. Name the output Community SFHA.
4. Open Federal Lands and Select by Attributes areas greater than 10 acres.
   a. If using PADUS1_4MPA shapefile, select polygons where “Owner Type” = “Federal”
   b. Add a new Double field to the attribute table, right-click on the new field, and select Calculate Geometry.
   c. Select Area as the Property.
   d. Use the coordinate system of the data frame.
   e. Select acres, and click OK.
5. Open Hydrology and Select by Attributes water bodies greater than 10 acres and large rivers with average bank-to-bank width exceeding 500 feet.
   a. If using National Hydrography Dataset (NHD), Merge NHD24Kwb (water bodies) and NHD24Kar (area).
   b. If area is not included, add a new Double field and Calculate Geometry.
   c. Use the measure tool to measure the distance between the banks of visibly large rivers.
6. Merge selected federal lands and water bodies. Name the output Areas Not Included.
7. Go to ArcToolbox -> Analysis Tools -> Overlay -> Erase12 to remove Areas Not Included (Erase Features) from the Community SFHA layer (Input Features). The output layer is the impact adjusted SFHA, or aSFHA.
8. Dissolve the aSFHA layer to a single record using an attribute table field with the same value (e.g. “SFHA_TF” values should all be ‘T’)
9. Add a new Double field, ‘aSFHA’, in the attribute table of the dissolved aSFHA layer and calculate the area (right-click, Calculate Geometry). This is the denominator in the impact adjustment ratio.

11 SFHA flood zones are A, AO, AH, A1-A30, AE, A99, AR, AR/AE, AR/AO, AR/A1-A30, AR/A, V, VE, V1-V30. The zones are listed in the “FLD_Zone” field of the attribute table. Note: not all FIRMs will have all of these zones.

12 “Erase” tool requires a Spatial Analyst extension.
Figure 1: GIS workflow diagram for Step 1
Figure 2: Output map from Step 1 that shows the SFHA, excluded areas, and impact-adjusted SFHA (or aSFHA).
Step 2. Identify Lands That May Qualify for Open Space Preservation Credit.

Overview:

Communities earn open space credit for 1) “preserved” lands, typically for individual parcels, or 2) lands “protected” through land development regulations. Open space means there are no buildings, storage, fill, significant pavement, or other encroachment to flood flows. Lands that are simply vacant do not qualify for credit and must be protected from future development through land use regulations or by the property owner. The objectives of Step 2 are to

Identify parcels that intersect the impact adjusted special flood hazard area or regulatory floodplain. NOTE: The GIS analysis for Step 2 focuses on identifying parcels that contain eligible preserved open space in the SFHA only.

Query parcel data and intersect map layers of land types that may qualify as “preserved” open space.

See Section 422. in the CRS Coordinator’s Manual.

➢ Types of public land: State and local parks and easements kept as open space (as documented by the owning agency). Examples include state, county, and city parks and forest preserves, publicly owned beaches or natural areas, school playing fields, cemeteries, and floodplain easements dedicated to the community by developers. Federal lands do not qualify for credit.

➢ Types of private land: Private wildlife or nature preserves, or private parcels with conservation easements maintained for open space purposes for at least five years (as documented by the owner or deed restriction). Examples include church retreats, hunting club lands, land with conservation easements, golf courses, nature preserves, or camping areas owned by nonprofit associations.

(Optional) Identify open space areas subject to land development regulations prohibiting building and filling that may qualify for credit and map those areas. Section 422. in the CRS Coordinator’s Manual.

Consider the following:

➢ The regulations or use restrictions must prohibit construction of new buildings, filling, grading, or other activities that obstruct flood flows or remove flood storage in areas subject to riverine flooding. It is permissible to maintain existing levees, engineered dunes, and beach nourishment within the area.

➢ If an ordinance prohibits residential development in the V Zone, floodway, or other portion of the floodplain, the community may request OSP credit for only those areas of the floodplain that are

13 Credit is only given for regulated lands that are undeveloped at the time of application for CRS credit.
zoned for residential use.

The area where the regulations are in effect must be mapped or defined by lots or a legal description. For example, credit will not be given for a wetlands regulation that depends on site analysis to define whether a property is a wetland.

**NOTE:** Land cover data can be used to identify open space areas that have high amounts of qualifying land cover types. To determine whether these areas qualify as preserved open space, the community must provide documentation that they are subject to land development regulations or are protected through ownership or conservation easement. The simplest approach to identifying preserved open space parcels and their protected status is by using a protected areas database. However, a GIS analyst can use land cover to investigate parcels that were not selected using the protected areas layers, but still have high amounts of qualifying natural land cover types. This layer is also referred to when considering FUTURE open space options in Step 7.

**Input GIS Data Sets:**

- aSFHA (created in Step 1) or regulatory (500-yr) floodplain (if larger)
- Parcels
- Land Use
- Protected Areas

**Optional:**

- Conservation Easements
- Preserved/Protected Community Open Space
- Coastal/Stream Setback Lines
- Land Cover

**Output GIS Layer:** Parcel area of eligible OSP that will be used to calculate the total area of land preserved as open space (aOSP) in the regulatory floodplain.

**GIS Analysis:**

1. If parcel area is not included in the attribute table of the Parcels layer, create a new field for total parcel area (e.g., PARCEL_AC) and calculate the area in acres. *Total parcel area should be included in the spreadsheet submitted to FEMA.*
2. **Clip** Parcels (input feature) using aSFHA (clip feature). Name the output layer Parcels_aSFHA.
3. Create a new field (e.g. SFHA_AC) and calculate the area. *This determines the amount of parcel area within the SFHA.*
4. Select parcels with OSP-qualifying land uses\(^{14}\) by querying (Select by Attributes) Parcels_aSFHA, and then save as a new layer.
   a. If there is no land use field in the attribute table of the parcel layer, **Open Land Use** and

\(^{14}\) Parks/recreation, urban open space, natural areas
the Zonal Statistics (MAJORITY) tool for raster data, or Spatial Join (Join Operation: JOIN_ONE_TO_ONE) for vector data to select qualifying land uses and save as new layer.

5. **Open Protected Areas** (if available, also include Conservation Easements, Community Open Space, and Coastal/stream Setback Lines)

6. **Select** and delete all federally owned areas. If using the PAD-US database, query the ‘Own_Type’ and/or ‘Mang_Type’ fields and **Select by Attributes** all non-federal features, then save as a new layer.

7. **Merge** Protected Areas, Conservation Easements, and Community Open Space layers into a single, new output dataset.

8. **Intersect** the merged protected areas layer with Parcels_aSFHA.

9. **Dissolve** the output layer by the unique parcel ID field (e.g., APN)\(^{15}\) to remove duplicates. Select the ‘Own_Type’ and/or ‘Mang_Type’ as the Statistics Field where ‘MAX’ is the Statistic Type.

10. Create a new field (e.g., “OSP_AC”) and calculate the area of each parcel that is covered by OSP. This determines the amount of parcel area within the SFHA that is eligible for OSP.

11. Right-click on Parcels_aSFHA, select Join and Relates -> select Join. In the Join Data dialog: “Join attributes from a table” using the unique parcel ID field. Choose the table from the dissolved layer created in Step 2(9), and choose the parcel ID field to base the join on. This will join attribute fields.

12. **Open** the attribute table of Parcels_aSFHA, right-click on ‘OSP_AC’ and **Sort Descending**.

13. **Select by Attributes** where ‘OSP_AC’ > 0.

14. Right-click on Parcels_aSFHA, go to Data -> Export Data, rename the output file (e.g. Eligible_OSP_Parcels). This will make the join permanent. Delete duplicate fields (e.g., APN_1)

Optional – Identify land development regulations:

15. **Select by Location** Parcels_aSFHA where parcel polygons intersect Eligible_OSP_Parcels, then use

16. **Switch Selection** to reverse the selection and save as a new layer as Eligible_OSP_Parcels_Regs.

17. **Open Land Cover**\(^{16}\)
   a. If Land Cover is a raster, convert Raster to Polygon. Do not simplify polygons.
   b. In attribute table of the Land Cover polygon, **Select by Attributes** natural land cover classes,\(^ {17}\) including developed open space, and save the output layer as Open Space.

18. **Intersect** the Open Space and Eligible_OSP_Parcels_Regs layers.

19. **Dissolve** the output layer using the parcel ID as the Dissolve Field and select ‘SFHA_AC’ as the Statistics Field where ‘FIRST’ is the Statistic Type.

20. Add a new Double field (e.g. ‘InterArea’) to the output of the Dissolve operation. Right-click ‘InterArea’ and select Calculate Geometry.


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\(^{15}\) If APN is not a standard field in the parcel database, create a new field in the attribute table and generate a unique ID number for each parcel.

\(^{16}\) If available, a structure layer may also be used to identify vacant parcels.

\(^{17}\) Natural land cover includes categories such as forest, shrubs, grasslands, bare, wetlands, and any other areas in their undeveloped, natural state. It does not include the water class.
22. Right-click on ‘Percentage’ and **Sort Descending**. For parcels that contain a high percentage AND large area (InterArea) of open space, determine if qualifying land development regulations exist for those parcels by contacting city or county departments that can locate regulatory documents for a particular parcel.

23. **Select** parcels with qualifying regulations and **Merge** with *Eligible_OSP_Parcels* created in Step 2(14).

**Figure 3: GIS workflow diagram for Step 2**
Figure 4: Output maps from Step 2 that shows parcels containing areas of preserved open space
Step 3. Exclude Areas That Do Not Qualify for Open Space Credit.

Overview:
In addition to federal lands and large water bodies, several types of areas do not qualify for credit. Such areas include parcels smaller than 10 acres that contain an insurable building,\(^{18}\) large areas with impervious surfaces, features that serve the development or use of an area, parcels on which certain land uses or encroachments obstruct flood flows or aggravate flooding on other properties, and publicly owned land that is not intended for open space. Fill, storage of materials, or other encroachments also need to be excluded\(^{19}\) because they aggravate flooding by creating obstructions to the flow or loss of storage of floodwaters. The objectives of Step 3 are to

*Identify federal lands and open water areas in the regulatory floodplain, if using* to determine eligible OSP, and exclude from consideration at the parcel-level.

*Calculate the portion of qualifying OSP parcels covered by impervious surfaces, linear features, and rights-of-way* that are necessary to serve the development or use of an area.

- **Impervious surfaces:** Areas with large amounts of impervious surfaces, such as driveways, parking lots, buildings, or paved amenities (e.g., ball courts). Do not exclude minor areas such as sidewalks, trails, or pervious pavements. See Section 422.a.

- **Linear features and rights-of-way:** Streets, pavement, parkway, railroad, levee, canals, ditches, and channels. See Section 422.a.

Input GIS Data Sets:
- *High-Resolution Land Cover,* or
- *High-Resolution Imagery,* or
- *NLCD Percent Impervious*

If using the regulatory (500-yr) floodplain for OSP:
- *Federal Lands*
- *Hydrology*
- *Eligible OSP Parcels* (created in Step 2)

Output GIS Layer: Federal lands and water bodies removed from eligible OSP parcels in the regulatory floodplain, if using, and impervious surfaces for calculating area of eligible OSP in Step 4.

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\(^{18}\) Some exceptions apply – see the CRS *Coordinator’s Manual* for details.

\(^{19}\) This does not apply to construction of sand dunes, beach nourishment, and habitat restoration projects.
GIS Analysis:

NOTE: If using the aSFHA calculated in Step 1 to identify eligible OSP, start at Step 3(3).

1. Open Federal Lands and Hydrology, then follow Step 1(4-6).

2. Select parcels that intersect the merged federal lands and water layer and delete these parcels from eligible OSP parcels created in Step 2.

3. Choose ONE OF FOUR options to create an Impervious Surface layer:
   - OPTION 1: Open high-resolution Land Cover and Reclassify "developed" classes to an Impervious Surface layer.
   - OPTION 2: Open NLCD percent impervious raster and use Zonal Statistics as Table to calculate ‘mean’ percent impervious surface per parcel (by unique parcel ID), then Join the output table to Eligible_OSP_Parcels using the unique parcel ID. Ensure the ‘mean’ field is visible in the attribute table and save as a new layer to make the join permanent. Open the attribute table of the output layer, create a new field (e.g., IS_AC) and use Field Calculator to set the field equal to ([MEAN]/100)*PARCEL_AC.
   - OPTION 3: Open high-resolution imagery and perform image classification.
   - OPTION 4: Open high-resolution imagery and hand digitize impervious surfaces.

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20 If using ArcGIS Pro, see the tutorial on how to Calculate Impervious Surfaces from Spectral Imagery.
Figure 5: Map showing impervious surfaces layer and parcels with preserved open space in the aSFHA
Step 4. Calculate Possible Credit for the Community’s Preserved Open Space.

Overview:
For parcels that qualify as preserved open space, credit is based on the portion of property within the regulatory floodplain that qualifies as open space. OSP credit is calculated based on the ratio of preserved open space in the regulatory floodplain to the adjusted special flood hazard area, also known as the “impact adjustment” ratio. The total acreage of preserved open space in the regulatory floodplain (aOSP) is divided by the total acreage of the community’s special flood hazard area (aSFHA), and then the resulting ratio (rOSP) is multiplied by 1,450 to determine the number of credits that could be earned for the preserved open space parcels. The objectives of Step 4 are to:

1. Calculate the portion of each parcel that qualifies as preserved open space within the aSFHA, or the regulatory floodplain, if larger.
2. Calculate total area within the aSFHA (or regulatory floodplain, if larger) that qualifies as preserved open space, or aOSP. This number will serve as the “numerator” for calculating potential credit.
3. Calculate the impact adjustment ratio to determine the total number of OSP credit that can potentially be earned by the community.  

Input GIS Data Sets:
- aSFHA (created in Step 1)
- Eligible OSP Parcels (created in Step 2)
- Impervious Surfaces (created in Step 3)

Output GIS Layer: Eligible OSP parcels with new fields in the attribute table for impervious surfaces, total area of land preserved as open space (aOSP), and potential points for OSP credit.

GIS Analysis:
1. Right-click on aSFHA and open the attribute table to note the value in the ‘aSFHA’ field. This is the denominator in the impact adjustment ratio for the OSP element.
2. Intersect Eligible OSP Parcels and Impervious Surfaces, then Dissolve the output layer by the unique parcel ID field (e.g. APN) to remove duplicates.
3. Create a new Double field (e.g., “IS_AC”) and calculate the area of each parcel that is covered by impervious surfaces (right-click on ‘IS_AC’, Calculate Geometry).
4. Right-click on Eligible OSP Parcels, select Join and Relates -> select Join. In the Join Data dialog, “Join attributes from a table” using the unique parcel ID field. Choose the table from the output layer created in Step 4(1) containing the “IS_AC” field and choose the parcel ID field to base the join on.
5. Right-click on Eligible OSP Parcels and select Data -> Export Data, rename the output file Eligible OSP Parcels_IS. This will make the join permanent. Delete duplicate fields (e.g. APN_1).
6. Open Eligible OSP Parcels_IS and create a new Double field, “aOSP”, in the attribute table.

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21 FEMA will verify during a site visit before allocating credit to parcels.
7. Right-click on ‘aOSP’ and select **Field Calculator** to set the field equal to \([\text{OSP\_AC}] - [\text{IS\_AC}]\). *This is the numerator in the impact adjustment ratio for the OSP element.*

8. Right-click on ‘aOSP’ and select **Properties** to round to two decimal places\(^{22}\) and delete polygons with an area smaller than 0.01. This will eliminate slivers and small areas that result from performing intersect in previous steps.

9. Create a new Double field, ‘OSP\_pts’, for calculating potential OSP points per parcel.

10. Right-click on ‘OSP\_pts’, select **Field Calculator** and set the field equal to \((aOSP/aSFHA)\ast 1450\). *NOTE: aSFHA value should be manually entered.*

11. Make sure the attribute table of the *Eligible OSP Parcels\_IS* contains the following:
   - APN or ID
   - Parcel owner
   - Land use designation
   - Parcel area (‘PARCEL\_AC’)
   - Parcel area within the SFHA (‘SFHA\_AC’)
   - Parcel area in the regulatory floodplain and flood zone of parcel (if applicable)

   *NOTE: Calculations can either be completed in GIS or export attribute table as spreadsheet to finish calculations in *Job Aid – Worksheet to Calculate Open Space Credit* (Excel spreadsheet). The job aid is appropriate for a handful of parcels, but if the GIS analysis reveals hundreds of eligible parcels for OSP (e.g., for a large county), then calculating in GIS is probably a better option.*

\(^{22}\) ISO currently rounds this impact adjustment to two digits prior to determining the points. Then rounds again for the final score.
Figure 6: GIS workflow diagram for Step 4
Figure 7: Output map for Step 4 showing an example of parcel area that qualifies for OSP credit
Step 5. Determine Whether Preserved Open Space Parcels Qualify for “Extra Credit.”

NOTE: This step is optional and not required. Please skip to Step 6 if not completing extra credit analysis.

Overview:

Parcels that qualify as preserved open space (OSP) may qualify for “extra credit” if they are protected by deed restrictions or provide natural functions. Determine which of these situations, if any, apply to the open space parcels and calculate the additional credit for each category. The objectives of Step 5 are to

1. **Determine whether any of the parcels have Deed Restrictions (up to 50 points).** The parcel acreage that qualifies for deed restrictions (aDR) is divided by the total acreage of the community’s floodplain (aSFHA) and then the resulting ratio (rDR)\(^23\) is multiplied by 50 to determine the number of credit that could be earned for deed restrictions. See Section 422.b of the **CRS Coordinator’s Manual**.

2. **Determine whether any of the parcels qualify as Natural Functions Open Space (up to 350 points).** Parcels that qualify as preserved open space may receive additional credit if they are
   - **NFOS1** = open space parcels preserved in their undeveloped natural state, or that were formerly farmed or developed but restored to their natural, pre-development conditions\(^24\) (up to 190 points)
   - **NFOS2** = parcels that qualify as NFOS1 and are designated in a natural floodplain functions protection plan that meets the criteria for such plans\(^25\) as described in Activity 512.c (Floodplain Management Planning) (up to 50 points)
   - **NFOS3** = parcels that qualify as NFOS1 and are designated as critical habitat for threatened or endangered species or if the species is present. This includes species already on an official federal or state list\(^26\) as threatened or endangered or as a “species of concern”\(^27\) (up to 50 points)
   - **NFOS4** = parcels that qualify as NFOS1 and are in an open space corridor or connected network (e.g. wetlands, woodlands, or wildlife habitats) designated in an approved plan\(^28\) (up to 60 points)

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\(^{23}\) rDR cannot be greater than rOSP  
\(^{24}\) NFOS1 is a prerequisite to receive credit for the other four types of natural functions open space elements.  
\(^{25}\) Habitat conservation plan, habitat protection or restoration plan, “green infrastructure plan,” comprehensive plan, or other community plan that recommends actions to protect the ecological attributes of the watershed or floodplain.  
\(^{26}\) Parcel boundaries can be uploaded to or drawn in USFWS’ iPAC database to see if habitat for T&E species is present (https://ecos.fws.gov/ipac/location/index). The following website provides unofficial critical habitat maps for NOAA’s trust species (http://www.nmfs.noaa.gov/pr/species/criticalhabitat.htm).  
\(^{27}\) For Federally listed species, use USFWS’ iPAC website to see what species might be present on each parcel or see maps showing critical habitat for marine species under NOAA’s jurisdiction. Or consult with your state’s wildlife or natural resource agency.  
\(^{28}\) State CELCP plans or state wildlife action plans may be good sources for this information.
The total acreage of qualifying areas (aNFOS#) is divided by the total acreage of the community’s special flood hazard area (aSFHA), and then the resulting ratio (rNFOS#) is multiplied by up to 350 to determine the number of credits that could be earned for NFOS#. See Section 422.c. of the CRS Coordinator’s Manual.

In this step, it will be helpful to work with the community’s CRS Coordinator or local planners to determine whether a parcel qualifies for each of the credits in this section. For example, the coordinator can help determine
- what portion of the property, based on the deed language, qualifies as deed-restricted (the National Conservation Easement Database is also a helpful source for easement shapefiles);
- whether the property is in, or has been restored to, its natural state. This qualification for NFOS1 is a prerequisite for the other NFOS credit; and
- which, if any, of additional NFOS credit a property may qualify to earn.

**Input GIS Data Sets:**
- aSFHA (Step 1)
- Eligible OSP Parcels_IS (Step 4)
- Protected Areas

**Optional:**
- Critical Habitats
- Conservation Corridors
- Floodplain Protection

**Output GIS Layer:** Eligible OSP parcels with new fields in the attribute table for deed restriction and NFOS points.

**GIS Analysis:**

**Deed Restrictions (DR)**

1. In Eligible OSP Parcels_IS, open the attribute table and create field called “Deed.”
2. Right-click on Eligible OSP Parcels_IS and Edit Features -> Start Editing, then enter ‘1’ for all parcels with deed restrictions. Save Edits.
3. Create new Double field, ‘DR_pts’, for calculating potential DR points per parcel.
4. Right-click on ‘DR_pts’ and use Field Calculator to set the field equal to ([aOSP]/aSFHA)*50.

**NOTE:** Only the portions of a parcel that qualify for OSP can qualify for DR, therefore the aOSP field can be used to calculate aDR. In some cases, aDR may only cover a portion of the area that qualifies as OSP due to restrictions within a conservation easement that exclude certain portions of the OSP.

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29 ISO currently rounds this impact adjustment to two digits prior to determining the points, and then rounds again for the final score.
property, such as a reserved “building envelope.” The portion of the OSP property covered by the “building envelope” would not qualify as deed restricted.

Natural Function Open Space (NFOS)

5. **Intersect** Eligible OSP Parcels IS and Protected Areas, and then **Dissolve** the output layer by the unique parcel ID field (e.g. APN) to remove duplicates.
6. In the dissolve output layer, open the attribute table and create two new fields: ‘NFOS1’ (Type: String) and ‘NFOS1_AC’ (Type: Double).
7. Right-click on the dissolve output layer and **Edit Features** -> **Start Editing**, and then enter ‘1’ in ‘NFOS1’ field. **Save Edits**.
8. Right-click on ‘NFOS1_AC’ and select **Calculate Geometry** to calculate the area of each parcel that qualifies as NFOS1.
9. Repeat Steps 5(5-8) for NFOS2-NFOS4 using the following GIS layers, if available:
   a. NFOS2 – Floodplain Protection
   b. NFOS3 – Critical Habitat
   c. NFOS4 – Conservation Corridor
   **NOTE:** **Intersect** using the NFOS1 dissolve output layer created in Step 5(5) and the NFOS2-NFOS4 relevant GIS layers in replacement of Eligible OSP Parcels IS and Protected Areas.
10. Right-click on *Eligible OSP Parcels IS*, select **Join and Relates** -> select **Join**. In the Join Data dialog: “Join attributes from a table” using the unique parcel ID field. Choose the table from the output layer created in Step 5(5) containing the ‘NFOS1’ and ‘NFOS1_AC’ fields, and choose the parcel ID field to base the join on.
11. Repeat Step 5(10) for layers created in Step 5(9) for NFOS2, NFOS3, and NFOS4, if applicable.
12. Right-click on *Eligible OSP Parcels IS* and select **Data** -> **Export Data**, rename the output file Eligible OSP Parcels_NFOS. This will make the join permanent. Delete duplicate fields (e.g. APN_1).
13. Create new Double field, ‘NFOS1_pts’, for calculating NFOS1 points per parcel.
14. Right-click on ‘NFOS1_pts’ and use **Field Calculator** to set the field equal to ((NFOS1_AC)/aSFHA)*190.
15. Repeat Steps 5(13-14) for NFOS2, NFOS3, and NFOS4, if applicable. **NOTE:** Eligible points are different for each NFOS#.

**NOTE:** Calculations can be done in GIS or export attribute table as spreadsheet to finish calculations in Job Aid – Worksheet to Calculate Open Space Credit (Excel spreadsheet).

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30 NFOS 2 may be included here if a community has parcels that are designated in a natural floodplain functions protection plan as described in Activity 512.c
Step 6. Gather Supporting Documentation for Each Parcel or Area to Submit to FEMA.

Overview:
To determine the final number of credits that can be awarded for each activity, FEMA will need to review documentation provided by the community and conduct a verification visit. The documentation needed for each element is summarized in the NOAA “How To” Guide, and described in more detail in the CRS Coordinator’s Manual. The objectives of Step 6 are to

*Produce a map that labels which parcels qualify for OSP, DR, and NFOS credit. This is the “impact adjustment map.” If the community is large and parcels are hard to see, create multiple impact adjustment maps. See Section 403 of the CRS Coordinator’s Manual.*

*Provide a list of parcels that may qualify for open space credit.* The list must correspond to the impact adjustment map and include parcel owner, land use designation, acreage of parcel, and acreage of the parcel within the SFHA. If using areas the community regulates outside of the SFHA, the acreage of the parcel in the regulatory floodplain and the flood zone of the parcel must also be included.

NOTE: Check with your ISO/CRS specialist to see if there is additional information they would like included on the impact adjustment map or in the parcel list.

Input GIS Data Sets:
- aSFHA (Step 1)
- Regulatory Floodplain (if using for OSP credit)
- Excluded Areas (Step 1)
- Eligible OSP parcels_IS (Step 4, or Step 5 if completed)

Output GIS Layer: The impact adjustment map and list of parcels as a shapefile and Excel spreadsheet

GIS Analysis:
1. Create a base map that includes streets, scale, and a legend of all map layers.
2. Overlay the aSFHA and Eligible OSP Parcels (if using, include Regulatory Floodplain\(^{31}\)).
3. Symbolize aSFHA using outlined or shaded polygons to show the flood zones.
4. Symbolize Excluded Areas from the calculations using outlined or shaded polygons.
5. Symbolize Eligible OSP Parcels using outlined or shaded polygons to show the portion of each creditable open space property.

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\(^{31}\) The community must map the area and document its floodplain management regulations, per Activity 410 (Floodplain Mapping).
6. Label *Eligible OSP Parcels* using the unique parcel ID.

7. Label *Eligible OSP Parcels* to show which parcels qualify for extra credit based on deed restrictions (mark as “DR”), natural functions (mark with “NFOS#”).

8. Export *Eligible OSP Parcels* attribute table as .txt to import into an Excel spreadsheet.

   http://support.esri.com/technical-article/000012471

Figure 8: Example of an impact adjustment map
Figure 9: Example of shapefile attribute table for export
Step 7. Identify Opportunities to Earn More Open Space Credit.

**NOTE:** This step is optional and not required.

**Overview:**

Identify unprotected areas that may potentially qualify for open space preservation credit within your community if protected in the future, such as undeveloped natural lands, lands designated in a natural floodplain functions protection plan, open space corridor, or as critical habitat for threatened or endangered species. The objectives of Step 7 are to

- **Conduct an initial screening to identify lands most likely to earn open space preservation credit in the future** and select the 10 largest parcels within the SFHA.
- **Evaluate feasibility and prioritize opportunities to protect additional lands as open space** through such means as acquisition, easement, or other type of protection.
- **Explore opportunities to earn credit for lands protected** through low-density zoning, open space incentives, and shoreline or special flood hazard protection programs.

- **Open Space Incentives:** A community can receive credit for open space incentives, such as density transfers, transfer of development rights, cluster developments, planned unit developments, and setback rules (e.g. buffers for shorelines or wetlands). See Element 422.f. on page 420-21 of the CRS Coordinator’s Manual for more information.
- **Low-density Zoning:** A community can receive credit for ≥ 5-acre lots with zoning designations that keep the floodplain substantially open, such as zoning for agricultural uses, conservation, or low-density residential use. See Element 422.g. on page 420-28 of the CRS Coordinator’s Manual for more information.
- **Natural Shoreline Protection:** A community can receive credit for programs that protect unarmored channels and shorelines in their natural state. See Element 422.h. on page 420-30 of the CRS Coordinator’s Manual for more information.
- **Special Flood Hazard Areas:** Communities can earn credit for open space preservation and low-density zoning in areas subject to special inland and coastal flood hazards. Inland flood hazards can include uncertain flow-paths (alluvial fans and channel migration, closed basin lakes, ice jams, land subsidence, and mudflows. Special coastal flood hazards include tsunamis as well as coastal erosion. See Element 422.d. on page 420-19 of the CRS Coordinator’s Manual for more information.

**Input GIS Data Sets:**

- Parcels_aSFHA
- Land Cover, or Open Space (Optional in Step 2)
GIS Workflow: Open Space Preservation
Community Rating System Credit

- *Eligible OSP parcels* (Step 4)

**Output GIS Layer:** Parcels ineligible for OSP credit, but contain large amounts of open space that may be eligible for OSP credit if permanently preserved through development restrictions or local regulations in the future.

**GIS Analysis:**

1. Follow Step 2(15-22), if not already completed.
2. For parcels that contain a high percentage AND large area (InterArea) of open space, see Step 4 to calculate
   a. the area of the parcel would qualify as preserved open space if protected, after excluding impervious surfaces or other non-qualifying uses, and
   b. potential point benefit if these parcels were included.
3. Determine whether the parcel could qualify for additional credit for natural functions open space (NFOS) and calculate potential extra credit (See Step 5).
4. Determine ownership\(^{32}\) and overlay zoning/regulatory restrictions.

   **NOTE:** This information can aid working with local land trust, open space committee, or nonprofit organizations to determine if these parcels are part of their planning efforts. Some landowners may be willing to consider donation of an easement to a qualified conservation organization. Consider protecting these parcels through voluntary approaches, such as purchase or transfer of development rights, acquisition of the land, or conservation easement or other deed restriction on the land. If already protected via zoning restrictions, work with your community’s CRS coordinator to determine whether these areas may qualify for credit.

5. If GIS data sets are available for repetitive loss\(^{33}\) or other areas where development should be removed and the land restored to its natural state, select the areas that are near existing open space parcels.

   **NOTE:** Property owners in these areas may be interested in selling, and a collaboration with a local land trust could provide the funding. This may also earn additional CRS credit for removing a repetitive loss structure from the floodplain.

\(^{32}\) An ‘owner type’ field in the parcel data is helpful here to prioritize privately owned land, which is more feasible to acquire as an easement.

\(^{33}\) The repetitive loss areas are already created per CRS requirements, and communities should know internally which structures are repetitive loss.