Chart Tile Service

NOAA Office of Coast Survey

Requirements Specification

Updated for Releases 4 and 5

1.0 Introduction

1.1 Purpose

This document specifies requirements for the next generation of NOAA Office of Coast Survey Chart Tile Service and solicits feedback from Coast Survey partner organizations. Direct comments to sam.debow@noaa.gov or to Coast Survey's Inquiry System.

The new Chart Tile Service will facilitate frequent chart updates for the public. It will eliminate the need for application developers to regularly undergo the cumbersome process of transforming NOAA BSB files into their own geo-referenced and quilted tilesets.

1.2 Definitions

Term	Definition
Tileset	A set of 256x256 PNG images representing a geographical area at multiple zoom levels.
Online tileset	A tileset published on a web server available for use by web applications.
Offline tileset	A tileset bundled in a single file to facilitate network transmission and offline use. Offline tilesets may also include chart metadata (including chart name, number, scale, zoom level, etc.).
Single chart tileset	A tileset representing a single NOAA chart at multiple zoom levels.
Quilted tileset	A multi-chart tileset covering a preset geographical area. Charts are quilted together to provide a seamless view.
Chart Tile Service	A service that will provide the online and offline tilesets, both single charts and quilted chart tilesets.
Chart Metadata Service	A service that will provide a chart metadata list (including chart name, number, scale, zoom level) relevant to a specific coordinate.
UTFGrid	A specification that defines a way to transport interactive data to a map interface so that it loads progressively and performs well across legacy browsers and modern mobile devices.
MBTiles	A specification that "provides a way of storing millions of tiles in a single SQLite database making it possible to store and transfer web maps as a single file."[1]
Zoom level	A zoom level is a number representing a distance from the surface of the earth. At zoom level 3, you can see most of the earth on your screen. At zoom level 18, you would be able to view a river or harbor from a large scale chart.

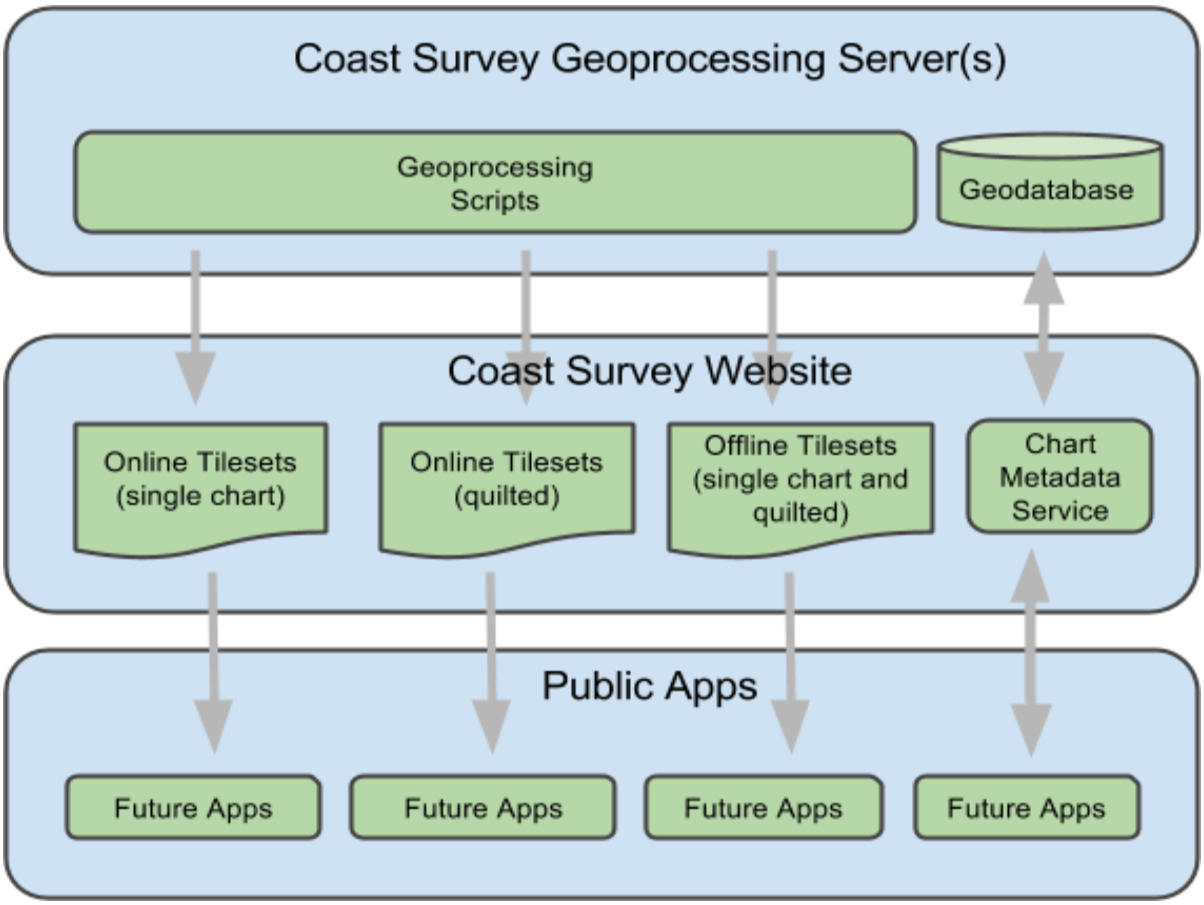
[1] https://www.mapbox.com/developers/mbtiles/

	As you “zoom in” the zoom level increases by 1 and the number of tiles, required to view an area covered by 1 tile at the previous zoom level, increases by a factor of 4.
Default zoom level	The (optimal) zoom level that best matches a particular chart’s scale. A large scale chart will have a higher zoom level than a small scale chart.
Zoom level gap	Quilted tilesets with one or more scales unpopulated. The quilted tileset typically has full chart coverage for zoom levels between the smallest and largest scale charts covering a particular point. In some cases there are no medium scale charts to populate a zoom level between that smallest and largest scale charts, resulting in “zoom level gaps”.
Delta updates	Delta updates refer to an update of an offline tileset packaged in the form of an MBTiles SQLite database. A delta update includes only the tiles that have changed.
TMS	TMS refers to the Tile Map Service specification.
WMTS	WMTS refers to the Web Map Tile Specification.
“Shall” Statement	The word Shall indicates a requirement. Shall statements are subject to verification.[2]
“Will” Statement	The word Will indicates a statement of fact. Will statements are not subject to verification.[3]
“Should” Statement	The word Should indicates a goal which must be addressed by the design but is not formally verified. Should statements are not subject to verification.[4]

[2] http://www.reqexperts.com/blog/2012/10/using-the-correct-terms-shall-will-should/
[3] http://www.reqexperts.com/blog/2012/10/using-the-correct-terms-shall-will-should/
[4] http://www.reqexperts.com/blog/2012/10/using-the-correct-terms-shall-will-should/

1.3 System Overview

The following diagram represents a high-level overview of the proposed Chart Tile Service.



1.4 References

Item	URL
MBTiles	https://www.mapbox.com/developers/mbtiles/
Example of a tile usage policy	http://wiki.openstreetmap.org/wiki/Tile_usage_policy
TMS Standard	http://wiki.osgeo.org/wiki/Tile_Map_Service_Specification

2.0 Overall Description

2.1 User Interfaces

The Chart Tile Service is designed for machine-to-machine use and will not have a user interface in the traditional sense. It provides data directly for web, desktop, and mobile applications. However, a website shall provide descriptions of the Chart Tile Service and Chart Metadata Service, access to the services, and sample viewers for the tilesets.

Interface	Description
Online Chart Tile Service	Organizations (other than Coast Survey) will develop Web applications to Coast Survey. Tiles will be generated according to the TMS and WMTS specifications.
Offline Chart Tile Service	Organizations (other than Coast Survey) will develop desktop and mobile applications.
Chart Tile Service Website	Coast Survey will establish a website to provide sample applications to demonstrate the use of online tilesets, offline tilesets, and the Chart Metadata Service.
Chart Metadata Service	Coast Survey will implement the chart metadata service as a REST web service. When a web or mobile application provides a coordinate via a URL parameter, the service will return a list of charts (and related metadata) containing that coordinate.

2.2 Hardware Interfaces

Interface	Description
Geoprocessing tools	A set of software tools capable of processing NOAA BSB files, transforming them into geo-referenced tilesets.
Geodatabase	An internal database to store all chart metadata including the outline coordinates. This will be the database for the Chart Metadata Service.
Web server	A public-facing web server that will host the Chart Tile Service

	website and the Chart Metadata Service.

2.3 Software Interfaces

Interface	Description
Geoprocessing Tools (GDAL)	A set of software tools capable of processing NOAA BSB files, transforming them into georeferenced tilesets.
Geo-database	An internal database to store all chart metadata including the outline coordinates. This will be the database for the Chart Metadata Service.
Web Server	A public-facing web server that will host the Tile Service Website and the Chart Metadata Service. The web service will need to be capable of hosting dynamic web content, such as the python-based Django web application framework.

2.4 Communication Interfaces

Protocol	Description
HTTP	HTTP will be used as the primary communication protocol for the web server.
HTTPS	HTTPS will be used to protect requests using API keys.

3.0 Functional Requirements

3.1 Online Chart Tile Service

3.1.1 General requirements

3.1.1.1 - All charts shall be georeferenced and accessible according to the TMS specification.
3.1.1.2 - A TMS metadata file shall be available for each tileset. (Example: http://tileservice.charts.noaa.gov/tiles/50000_1/tilemapresource.xml)
3.1.1.3 - All charts shall be cropped to remove their borders.
3.1.1.4 - All tilesets shall be published to a public-facing web server on a weekly basis

3.1.1.5 - The Online Chart Tile Service shall support interoperability with ESRI software by providing a Web Map Tile Service (WMTS) interface to the tilesets.

3.1.2 Chart Tile Service website

3.1.2.1 Website content

The tile service website shall include the following:

3.1.2.1.1 Website - Project Overview

Description of the Chart Tile Service.

3.1.2.1.2 Website - Developer Information

Links to relevant APIs, standards and project requirements.

3.1.2.1.3 Website - Terms and Conditions

Links to the usage policy and legal disclaimer.

3.1.2.1.4 Website - Open Source Licenses

Links to open source licenses and other credits.

3.1.2.1.5 Website - Tileset Locator

An interactive map providing a way to find and display single chart tilesets.

3.1.2.1.6 Website - Sample Viewers

Access to sample viewers for each tileset.

3.1.2.1.7 Website - Guides and Metadata

Links to the ArcGIS 10.1+ guide. Provides links to the Service, TMS, and JSON Metadata.

3.1.2.1.8 Website - Quilted Tileset Description

The quilted tileset and provide a description of the quilted tileset that includes a summary of the Chart Precedence Rules.

3.1.2.2 Browser compatibility

The tile service web site shall be compatible with the following desktop and mobile web browsers:

3.1.2.2.1 Windows Compatibility - Desktop/Mobile

3.1.2.2.1.1 The tile service web site shall be compatible with Desktop Internet Explorer 9+
3.1.2.2.1.2 The tile service web site shall be compatible with Desktop Firefox
3.1.2.2.1.3 The tile service web site shall be compatible with Desktop Chrome
3.1.2.2.1.4 The tile service web site shall be compatible with Mobile Chrome
3.1.2.2.1.5 The tile service web site shall be compatible with Mobile Firefox
3.1.2.2.1.6 The tile service web site shall be compatible with Mobile Safari
3.1.2.2.1.7 The tile service web site shall be compatible with Mobile Internet Explorer 9+

Any compatability issues should be documented and posted to the website as minimum system requirements. Refer to the OnLine Chart Viewer system requirements as an example.

3.1.3 Online single chart tileset

3.1.3.1 Metadata for Sample Viewers

3.1.3.1.1 Coast Survey shall publish a sample viewer (with source code) with each single chart tileset to demonstrate compatibility with ESRI, Google Maps, Mapbox Javascript, and OpenLayers APIs.

3.1.3.2 Default zoom level

For each single chart tileset, a default zoom level shall be selected that maps to the chart's scale.

The default zoom level is computed by open source software and maps a chart's scale to a zoom level. The larger the scale (e.g. 1:2500) the higher the zoom level (e.g. 17). The smaller the scale (e.g. 1:800000) the lower the zoom level (e.g. 6).

3.1.3.1 Multiple zoom levels

Each single chart tileset shall be represented by 8 zoom levels, 1 above the default zoom level, the default zoom level, and 6 lower (pyramid) zoom levels.

3.1.4 Online quilted tileset

3.1.4.1 Multiple zoom levels

The quilted tileset shall contain all zoom levels existing in the complete set of single chart tilesets. For example, if one single chart tile set has zoom levels 3-10, another has zoom levels 9-16, and a third has zoom levels 12-19, then the quilted tileset will include zoom levels 3-19.

3.1.4.2 Default Tile Precedence

Default chart precedence rules shall be applied in the following order:

3.1.4.2.1 Zoom Level Priority

Default (source tile) zoom levels matching the (display) zoom level of the target quilted tile shall be given priority.

3.1.4.2.2 Primary precedence by scale

For each zoom level, chart overlay precedence shall be ordered from smallest to largest scale, with the largest scale chart on top. For example: for two charts -- Chart A (scale 1:1500) and Chart B (scale 1:2500) -- at the same zoom level, Chart A has a larger scale than Chart B. Therefore, Chart A would appear to be displayed on top of Chart B.

3.1.4.2.3 Secondary precedence by edition date

For charts having the same scale, secondary ordering shall be based on the chart edition date, with newer charts on top.

3.1.4.3 Tile Precedence Overrides

The system shall provide the following means to override the default chart precedence rules.

3.1.4.3.1 Locked Tile Overrides

The system shall permit any source tile (for a target quilted tile) to be locked such that it takes precedence when quilted.

3.1.4.3.2 Tileset Overrides

The system shall permit precedence overrides, defined by a list of pairs, where one item in the pair shall be rendered on top of the other item, despite the previous rules. The first override pair will be ('11360_1', '11340_1') to ensure that kap 11360_1 (scale 1:456394) appears on top of kap 11340_1 scale (1:358596). This is overrides the first precedence rule (above) stating that larger scale charts shall appear on top of smaller scale charts.

3.1.4.3.3 Tile Density Overrides

3.1.4.3.3.1 Sort by pixel density

If more than 1 source tile meets the zoom level priority requirements above, they shall be weighted and sorted by pixel density.

3.1.4.3.3.2 Store tile bounds

The tile bounds shall be saved so that we can later find the area.

3.2 Offline Tile Service

3.2.1 Chart Tile Service website

The tile service website shall include the following:

3.2.1.1 Overview

The overview shall include a description of the Offline Tile Service and a link to the MBTiles catalog. The MBTiles catalog is a metadata file containing descriptions for all available MBTiles in TileJSON format.

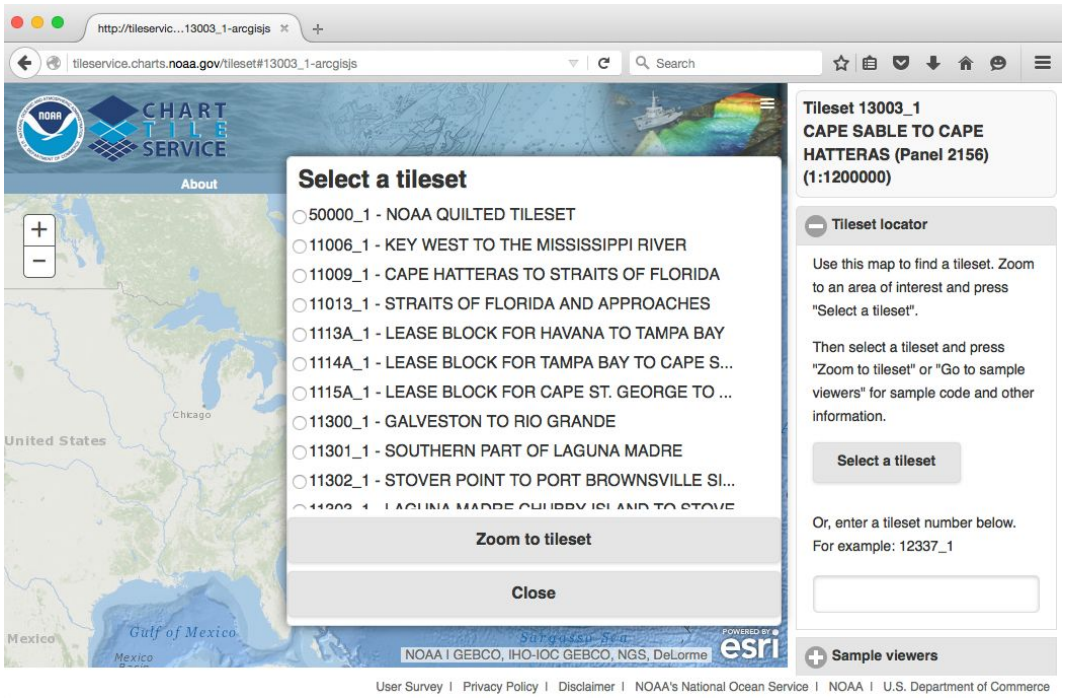
3.2.1.2 Tileset locator

The tileset locator shall provide a way to select a single chart or quilted tileset MBTiles file.

3.2.1.2.1 MBTiles for a single chart tileset

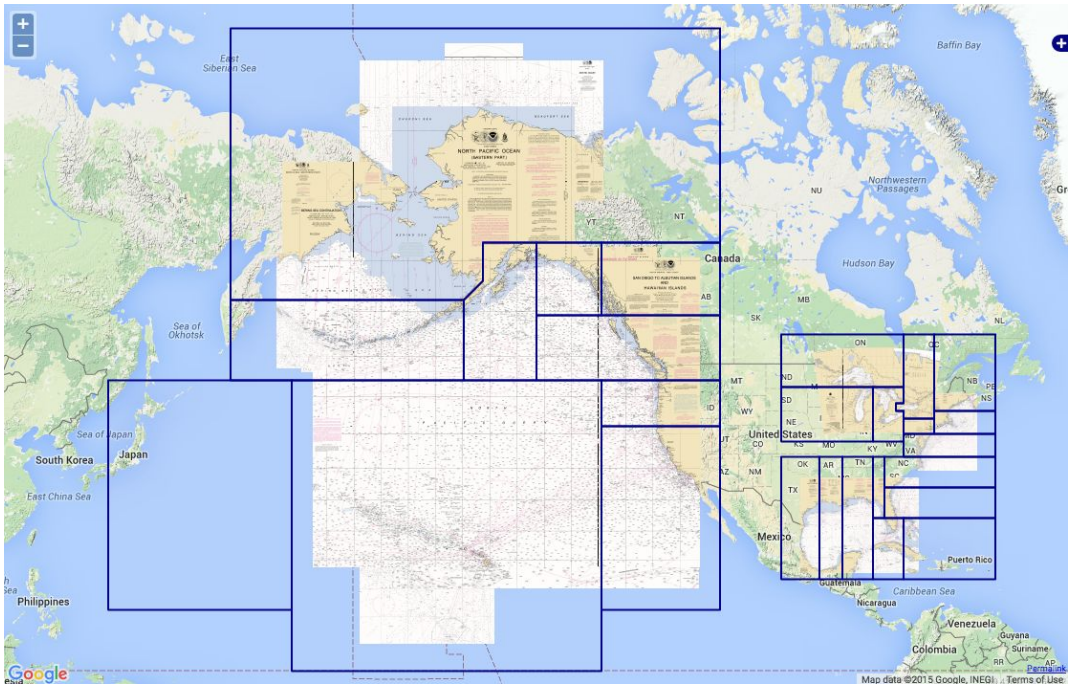
Single chart MBTiles files shall be accessed the same way that online single chart tileset are accessed. When a single chart tileset is selected, an MBTiles (side) panel shall also be

displayed in addition to the online sample viewers panel.



3.2.1.2.2 MBTiles for a quilted tileset section

The interactive map shall provide selectable sections, each representing an MBTiles region. When a region is selected, a collapsable MBTiles panel shall be displayed on the right side. The image below depicts how the MBTiles regions will be subdivided.



3.2.1.2.3 MBTiles panel

The MBTiles panel shall display the name, current update date, file size, and links to download the full tileset, delta-update tileset and delta-deletes tileset.

3.2.1.3 Sample apps panel

The Sample apps panel provides links for downloading sample iOS and Android projects that demonstrate use of the Offline Tile Service.

3.2.2 MBTiles Packages

3.2.2.1 General Requirements

3.2.2.1.1 The quilted tileset shall be divided into 26 regions.
3.2.2.1.2 An MBTiles package (or file) shall be provided for each region.
3.2.2.1.3 MBTiles packages shall not exceed a 600MB file size.
3.2.2.1.4 MBTiles packages shall be generated for both single chart and quilted tileset regions as a single file.
3.2.2.1.5 MBTiles packages shall be formatted according to the MBTiles specification.
3.2.2.1.6 MBTiles shall support interoperability with mobile iOS and Android applications.
3.2.2.1.7 MBTiles regions shall generally align with normal tile boundaries.
3.2.2.1.8 MBTiles regions shall not divide major ports and communities of interest/ high-traffic areas.
3.2.2.1.9 MBTiles shall be referenced in a metadata catalog and formatted according to the TileJSON specification.

3.2.2.2 MBTiles Metadata Fields

As defined by the MBTiles specification, the following metadata fields will be included in the SQLite database for each MBTiles package.

3.2.2.2.1 name - MBTiles package name
3.2.2.2.2 description - MBTiles package description
3.2.2.2.3 updated - The data and time that the MBTiles package was updated
3.2.2.2.4 size - The MBTiles package file size
3.2.2.2.5 profile - The spatial projection, e.g. mercator
3.2.2.2.6 attribution - Credits NOAA as the data provider
3.2.2.2.7 minzoom - The minimum zoom level containing tile data
3.2.2.2.8 maxzoom - The maximum zoom level containing tile data
3.2.2.2.9 bounds - Polygon defining the region boundary
3.2.2.2.10 url - URL to reach the MBTiles package

3.2.2.3 Offline single chart tilesets

3.2.2.3.1 MBTiles shall be provided for each single chart tileset.

3.2.2.4 Offline quilted tilesets

3.2.2.4.1 Offline quilted tilesets shall be divided by geographic grid.
3.2.2.4.2 A UTFGrid metadata record shall accompany each offline quilted tileset tile.

3.2.2.5 Delta Updates

A full and complete MBTiles file shall be available for download on a weekly basis. In addition, weekly delta-updates and delta-deletes MBTiles files will be included.

3.2.2.5.1 Delta-updates MBTiles file

The delta-updates MBTiles file is an update file with new tiles and tiles that have changed during the last week.

3.2.2.5.2 Delta-deletes MBTiles file

The delta-deletes MBTiles file references tiles that were deleted from the tileset during the last week.

3.2.3 Mobile demo apps for iOS and Android

The tile service website shall provide sample demo apps to showcase MBTiles offline compatibility.

3.2.3.1 General Requirements

3.2.3.1.1 The website shall provide instructions for downloading and configuring the mobile demo apps.
3.2.3.1.2 The Android demo app shall include an example for overzooming partially transparent tiles. The solution will look for tile data at upper zoom levels and (if found) rescale the chart data to fill in the transparent area.
3.2.3.1.3 The Android demo app shall include an example for overzooming tiles (usually found at large or medium scales) that do not have chart coverage.

3.2.3.2 User Interface Components

3.2.3.2.1 Sliding Menu

Users shall have the ability to select multiple MBTiles to be rendered simultaneously in the viewer.

3.2.3.2.2 Map Viewer

MBTiles shall be displayed as layers over a basemap.

3.3 Chart Metadata Service

3.3.1 Online Metadata Service

Given a geographic position, the Chart Metadata Service shall return chart metadata details for each chart covering the coordinate.

3.3.1.1 - Coast Survey shall publish sample viewers to demonstrate UTFGrid functionality with the OpenLayers, and Mapbox for Javascript APIs.

3.3.2 Static Metadata Files

The Chart Metadata Service shall provide a static metadata files for each tile.
3.3.2.1 grid.json - A companion grid.json file will accompany each tile (.png). The grid.json file shall contain a grid of ASCII characters representing a pixel area in each png file. Each UTFGrid character corresponds to a distinct feature retrieved using a key mapping.

3.3.3 UTFGrid Files

The static metadata file shall provide the ability to identify which NOAA chart is covered by each tile pixel area. This UTFGrid demo demonstrates a way to implement this requirement.

3.3.4 Tileset Metadata Files

The Chart Metadata Service shall provide metadata files for each tileset.
3.3.4.1 - TileJSON metadata (metadata.json)
3.3.4.2 - TMS Metadata (tilemapresource.xml)

4.0 Non-Functional Requirements

4.1 Performance Requirements

4.1.1 Tile usage policy

Users will need a tile usage policy to address terms of usage agreements. Find an example of a tile usage policy at http://wiki.openstreetmap.org/wiki/Tile_usage_policy.

4.2 Design Constraints

4.2.1 Community feedback

Coast Survey will accept public feedback. Additionally, Coast Survey will consult specific partner organizations before reaching any final design decisions.

4.3 Dependencies

Coast Survey will implement functional requirements in the following order:

1. Online single chart tilesets
2. Online quilted tilesets
3. Metadata
4. Offline chart tilesets
5. Delta updates