Service Level Specification (SLS)

Client Documentation

June 2025

Document type:	Service Level Standard (SLS)
Version:	Version 1.2
Approval date:	30 June 2025

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Version History

Document Version and Date	Update Summary
Version 1.0 (July 2023)	Original Document
Version 1.1 (September 2024)	Update Product Tiers
Version 1.2 (June 2025)	Updated Data Sharing

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1 Introduction

1.1 Purposes of This Document

The purpose of this document is to communicate FloodMapp's product service level specifications to FloodMapp's customers and end users. The document provides an overview of:

- Overview of FloodMapp's products ForeCast, NowCast and PostCast
- The product's intended purpose and applications and appropriate use cases
- Model specifications
- Service level overview
- Web service options
- Service level specifications
- Glossary of terms

1.2 Product Intent and Intended Purposes

FloodMapp software technology and products has been purpose built for emergency managers and asset owners (the Customer).

FloodMapp ForeCast, NowCast and PostCast products have been specifically developed for impact-based flood forecasting and operational flood risk management with the intent of providing emergency managers with situational awareness on flood risk and potential impact to people, property and critical infrastructure, before a flooding event, during a flood event and after a flood event. FloodMapp products provide a dynamic visualization of the flood impact and consequence as it occurs in real time to deliver real-time situational awareness in a way that is intuitive and useful to inform for operational decisions made by emergency managers during an active flood event.

FloodMapp products are not suitable for development planning or infrastructure design purposes.

The Customer (including it's personnel or End User) is ultimately responsible for:

- Correct use and application of FloodMapp Products for emergency preparedness, response and recovery.
- Interpretation of the forecasts and live intelligence contained within the Products.
- All decisions made using the Products
- Any physical actions taken based on their uses of FloodMapp Products before, during or after a flood event, including:
    - Early warnings/alerting
    - evacuation
    - road closures
    - swift water rescue
    - resource deployment
    - sand bagging/temporary flood barriers.

2 Product and Service Level Overview

2.1 Product Overview

An overview of each product is summarized below in Table 1 1.

Table 2-1. FloodMapp products

Product	Product description
FloodMapp **ForeCast**	**Future Forecasted Flood Model** FloodMapp ForeCast is a live mapping data feed service which can forecast the locations and severity of flooding for inland, localized and coastal flood events. FloodMapp ForeCast is an operational riverine forecast model powered by FloodMapp DASH hydrology and hydraulics models to predict the maximum flood inundation extent and/or depth in any region, within the next 6- to 72-hours, that will be inundated with 0.5-in or more of water. Models are run every hour, where sensor data is available, to refresh ForeCast outputs, which are valid for the duration of that hour. Results are delivered directly to your geospatial platform via an API connection. Flood impact mapping provides impact extents at street address resolution, with operational updates to the prediction to reflect changes in the real-time data inputs. FloodMapp ForeCast enables emergency managers and asset owners to: • Forecast location, severity, timing, and extent of flooding before it happens. • Provide intelligence about the potential impacts to people, property, and critical infrastructure. • Take action to ensure public safety through targeted alerting, road closures, and evacuations. • Protect sites/assets with temporary flood barriers. • Prioritize limited resources.
FloodMapp **NowCast**	**Live Real-Time Flood Model:** FloodMapp NowCast is live mapping data feed service which shows the real-time simulated maximum flood impact as flood inundation extent and depth. NowCast is powered by FloodMapp DASH operational hydraulics flood model, which is run every hour, where sensor data is available. NowCast represents any region where there is 0.5-in or more of water, where sensor data (e.g., riverine, pluvial, tidal, etc.) is available and valid for that hour.. NowCast results are updated hourly with model updates, and delivered directly to your geospatial platform via an API connection. This is calculated from observed river level data only. FloodMapp NowCast enables emergency managers and asset owners to: • Enhance operational situational awareness as a flood unfolds. Inform decision making to streamline response activities. • Keep critical personnel updated (including search and rescue teams or swiftwater field crews) • Take targeted action to maintain public safety and prevent loss of life with road closures and asset protection. • Improve routing and resource distribution as a flood is unfolding.
FloodMapp **PostCast**	**Post-event max flood inundation model** FloodMapp PostCast is a live mapping data feed service that enables analysis of actual flood levels and impacts after a storm has commenced. It answers the question “what was the maximum flood extent and/or depth for this flood event?”. FloodMapp PostCast is an operational Post-event riverine and coastal modelling service that is powered by FloodMapp DASH to represent the maximum inundation extent and/or depth over the previous 30 days. Results are updated every 12 hours and delivered directly to your geospatial platform as a live mapping data feed service via an API connection. Models are run twice a day at 12pm Coordinated Universal Time (UTC) and 12am UTC. FloodMapp PostCast enables emergency managers and asset owners to: • Analyze flood inundation levels and extent and impacts after a storm has commenced. • Undertake rapid desktop damage assessments to identify impacted communities and infrastructure to expedite recovery • Fast-track disaster declarations and public assistance funding applications • Resource planning for repairs and maintenance

2.2 License Tier Overview

The table below presents an overview of FloodMapp's product tiers and associated service level inclusions.

Service Level	Core	Professional	Enterprise
General Service Level (Applies to All Products)			
Flood Extent	✓ Flood extent raster	✓ Flood extent raster ✓ Flood extent polygon	✓ Flood extent raster ✓ Flood extent polygon
Flood Depth	Not included	✓ Flood depth raster (view only)	✓ Flood depth raster (view only)
Data Delivery	✓ view the data ✓ ArcGIS Online Dashboard	✓ Use data in my environment ✓ Interoperable live data feed API's: Web Map Service (WMS) Web Feature Service (WFS)	✓ Advanced analytics ✓ Interoperable live data feed APIs: Web Map Service (WMS) Web Feature Service (WFS)
Validation	✓ Validation of DASH model results (extent only)	✓ Validation of DASH model results (extent only)	✓ Validation of DASH model results (extent only) ✓ Validation to client-provided extent data or asset damage survey data. ✓ DASH model validated to client-provided spatial depth data ✓ Validation report
Service Availability	✓ 99.0% availability 24/7	✓ 99.5% availability 24/7 ✓ Business hours resolution of support requests	✓ 99.5% availability 24/7 ✓ Business hours resolution of non-urgent support requests ✓ 24/7 support for urgent service outage
Customization	Not included	✓ Federal gauge networks	✓ Annual maintenance / incorporation of client data (e.g. LiDAR, local & state stream gauges) for DASH model improvements
Analytics and Value Adds	Not included	Not included	✓ Impact analytics (one of building, asset, or road)
ForeCast			
ForeCast Lead Time	Not included	✓ 6-hour lead time	✓ >6-hour lead times (i.e., 12, 24, 72 hour)
Refresh Rate	Not included	✓ Hourly	✓ Hourly
NowCast			
Refresh Rate	✓ Hourly	✓ Hourly	✓ Hourly
PostCast			
Refresh Rate	✓ Every 12 hours	✓ Every 12 hours	✓ Every 12 hours
Historical Window	✓ 30 days	✓ 30 days	✓ 30 days ✓ Historical Flood Atlas scenario catalogue ✓ Additional historical extents – up to 2x major events validated and added annually to Flood Atlas

3 Model Overview

All products ForeCast, NowCast and PostCast are generated with FloodMapp's proprietary flood modeling technology DASH (Dynamic Automated Scalable Hydroinformatics).

DASH is an operational modelling technology specifically developed to deliver simulated water surface levels before, during and after a flood event to map the forecasted, current, or post-event flood extent and/or depth and serve this into data-as a service products and any associated service.

DASH delivers operational live mapping feeds for:

- ForeCast - impact-based flood forecasting,
- NowCast - real-time flood inundation modeling and impact mapping
- Post-Cast - post event inundation modelling and mapping.

DASH conducts all modeling in real-time using best-available real-time (or as close to) source data feeds.

FloodMapp takes a global model-based approach, where a single model is improved and published for the benefit of all clients. Therefore, the best available, most refined result will be published for any one area at any one time. This is achieved by collecting and processing vast amounts of live data from gauges and sensors and delivering impact mapping within minutes of the data being received.

3.1 FloodMapp DASH

DASH is a cloud-based, rapid, real-time flood modeling system that balances the scale, accuracy, and speed required for live mapping of flood inundation area and depth information in before, during, and after a flood event.

The DASH system (Figure 1) is composed of a set of tools, services, and models which serve to automate the end-to-end process of rapid flood modeling and forecasting, from the initial data gathering and cleaning, Digital Elevation Model (DEM) processing and hydrological model building, to calibration and forecasting, hydraulic model build, and two-dimensional (2D) flood extent generation.

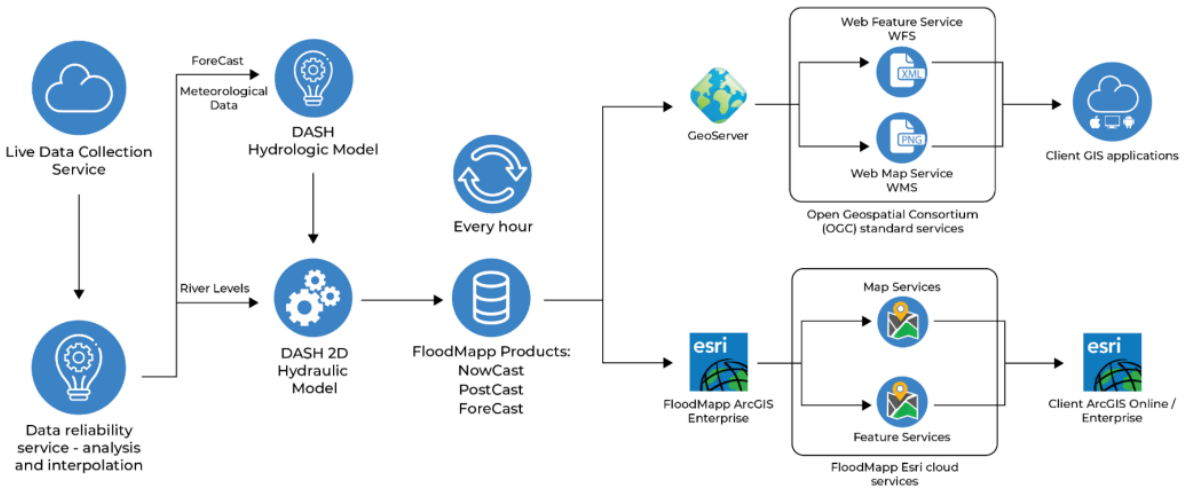

Figure 1. FloodMapp system architecture - integration into client GIS applications, including Esri.

The DASH Live Data Collection Service captures and analyzes real-time and forecasted rainfall, coastal, and river height data through large-scale cloud-based data pipeline infrastructure. This data is fed through the Data Reliability Service, where a set of Machine Learning (ML) models automate the data cleaning and quality assurance (QA) process to detect outliers and interpolate missing results. Outliers, which are common in most telemetry setups, are detected, flagged, and filtered automatically. Missing data values are

interpolated based on the trained relationship between the surrounding observation networks.

After all input data has passed through the Data Reliability Service, it is fed into the DASH pre-processor, which contains rapid, proprietary 1D-2D hydrology/hydraulic models (DASH Hydrologic Model and DASH 1D-2D Hydraulic Model) that combine physical hydrology and hydraulic approaches along with novel big data, analytics, and machine learning (ML) algorithms to estimate real-time and forecasted river heights and generate inundation mapping at scale.

The DASH Hydrologic Model (which underpins ForeCast) leverages physics-informed ML algorithms governed by the fundamental relationships between rainfall and runoff behavior, to simulate the stream or river height which is used to estimate the maximum flood extent and depth expected within the forecast horizon. The hydrology models leverage physical catchment characteristics such as catchment size and geometry, soil moisture and antecedent conditions, and ingested real-time and forecasted rainfall data. The model is calibrated to historic stream or river heights.

The DASH 2D Hydraulic Model simulates the expected hydraulic behavior of the flood, i.e., how water will flow over the terrain. Hydraulics are fundamentally based on a steady-state uniform flow assumption. It uses the highest available resolution of elevation data (e.g., 1-m in urban areas such as the City), major flood control structures, and the river and drainage network to inform the hydraulic model parameters. It takes in river heights as inputs and predicts the flood inundation extent and depth as a model output. The modeled flood water levels and underlying terrain data are used to derive flood depths and impact analytics.

The output of the DASH flood modeling software is FloodMapp ForeCast, NowCast, and PostCast, which provide inundation extent and/or depth for three key types of flood events: riverine flooding, pluvial or localized stormwater, and coastal flooding.

The pluvial and localized stormwater flood simulation capability of the DASH system can be enhanced and improved through the integration and deployment of an urban sensor network designed to monitor surface water across the area of interest. Similarly, accuracy of the riverine and coastal simulation can be improved through investment in additional river and tidal gauge sensors.

By applying a new set of algorithms and assumptions, DASH is able to achieve a very high level of computational efficiency while maintaining resolution to deliver significantly faster run times than industry standard models. Due to this computational efficiency, DASH is not constrained by the speed-resolution trade-off experienced by using traditional 1D-2D models, and thus DASH can use high resolution input data, even at scale.

FloodMapp's proprietary technology has been designed and built to be globally scalable and is already operational at a multi-state scale in the United States and Australia.

3.2 Model Input Data

A basic requirement of the DASH system is a Digital Terrain Model (DTM) of the area of interest. These DTMs can range from Light Detection and Ranging (LiDAR)-derived DEMs to the National Elevation Dataset (NED). Both the DASH Hydrologic Model and DASH 2D Hydraulic Model will use the highest quality elevation data available, including client-supplied LiDAR. FloodMapp will use data provided by the United States Geological Survey (USGS) 3D elevation program if no other terrain information is available.

In the United States, multiple stakeholders and agencies, including the USGS, the National Weather Service (NWS), and the National Oceanic and Atmospheric Administration (NOAA), make their real-time and historic surface water and coastal/tidal gauge data available to the public. The DASH Data Collection System automatically retrieves this data to serve as inputs to the modeling system. If additional gauging infrastructure is available for use, is currently unknown to FloodMapp, and meets technical requirements (e.g., those

gauging networks maintained by universities, nonprofits, local municipalities, and others), they can be added to the DASH Data Collection System for real-time inclusion. The sensitivity of the DASH system to City-provided data and sensors varies based on the location of each sensor and the density of the sensor network.

Operationally, FloodMapp ForeCast is driven by one of three gridded forecast rainfall products:

1) the Multi-Radar Multi-Sensor (MRMS) Quantitative Precipitation Estimation,

2) the High-Resolution Rapid Refresh (HRRR) Model, and

3) the European Center for Medium-Range Weather Forecast (ECMWF) Model.

The DASH system will primarily use the MRMS Quantitative Precipitation Estimation but will default to the HRRR model or ECMWF model in the order listed previously, if needed. Each gridded forecast rainfall product enables a wide range of options for temporal forecast windows, from 7-days to 1-hour before the flood event. For historical data validation, the MRMS Quantitative Precipitation Estimation is also the preferred historical rainfall model. However, it is possible for FloodMapp to use bespoke and proprietary gridded forecast rainfall products to replace these forecast rainfall products in select regional areas.

3.3 Model Calibration/Validation Approach

The purpose of DASH model calibration/validation is to assess the degree of similarity between modeled and actual results, as well as communicate the degree of confidence in the results to the end-user. Changes to the model will be made as needed to improve model results. DASH hydrology models are calibrated by qualified FloodMapp scientists and engineers using historical stream gauging records and evaluated using quantitative metrics such as the Nash-Sutcliffe Efficiency or Kling-Gupta Efficiency.

FloodMapp 1D-2D DASH models are calibrated to river/stream gauge levels. Validation of flood inundation extent and/or depth aims to compare historical, simulated model results against actual flood event data from same period that capture the extent and depth of flooding, such as aerial imagery, historical flood studies, or gauge data. Validation data must be precisely timed and geolocated within or nearby of a gauged waterway to match the timing and location of the simulated model results. A variety of historical flood events will be selected for validation to ensure that the model results are consistent against a variety of observed data types (e.g., flood magnitude, storm type, etc).

Examples of validation data that have been used in the past include road closure information, traffic camera imagery, high water marks, crowd-sourced photos and/or videos, drone imagery, media imagery, event-based flood studies, historical gauge hydrographs, and more. The goal is to collect a diverse array of nonpoint source (e.g., imagery) and point source data to accurately reflect the extent of flooding during a historical event for comparison to the ForeCast, NowCast, and PostCast model results.

The degree of confidence (i.e., model uncertainty) in model results is communicated to the client through a coverage map (to quantify NowCast and PostCast results) and a model confidence rating at each stream gauge location (to quantify ForeCast results). The categorization of model confidence within these rating systems describes overall model performance across all types of flood events (e.g., those driven by various storm types including nor'easters, tropical storms, cloud burst events, etc.). Quantification of expected performance is provided (e.g., "an estimate of flood extent and depth with a lead time and event amplitude that are within 75% of the time horizon and observed peak") to equip the end user with information needed to make buffer determinations about road closures, evacuation areas, and other area- or depth-defined decisions that account for the model uncertainty.

3.4 Inclusion of Future Data

One of the key advantages of the DASH system is that it is designed for sustainable, long-term use by enabling seamless integration of new physical, environmental data when it becomes available to keep the modeling system relevant and reflective of on-the-ground conditions.

For example, should a City, State or Federal agency decide to invest in expanding the existing gauging network, these new riverine, tidal, and/or pluvial (local stormwater) gauges can be easily ingested into the DASH system for operational use. After the gauges are brought online and connected to telemetry to transmit data in real-time, they can be utilized for NowCast and PostCast product generation almost immediately.

The usefulness of new gauges to the ForeCast product takes a little longer, requiring a period of record (~one year) before ForeCast can use the data for production. The ForeCast product will improve as the period of record at each stream gauge grows.

In addition to new gauge information, input terrain data can be easily and rapidly updated to reflect the most up-to-date topographical conditions across the modeled region, if and when new LiDAR data becomes available.

5 Product Specifications

5.1 Core Product Specifications

Item No.	Item	Specification	
1	ForeCast	Definition:	• FloodMapp ForeCast is a predictive data product that answers the question “what is the maximum flood extent and/or depth over the forecast horizon?”. FloodMapp ForeCast is an operational riverine forecast model which predicts maximum flood inundation extent and/or depth of an impending flood event for a given forecast horizon.
		Configuration:	• Data is available via geospatial APIs. OGC WFS & WMS standards, as well as ESRI Feature and Image Services. These APIs create new data layers within any Geospatial platform. • The standard forecast horizon is 6 hours. Models can be configured for bespoke forecast horizons at the Enterprise Tier, such as 24 hours, 72 hours, and, in rare cases, 7 days where sufficient data quality and quantity exists.
		Details:	
2	NowCast	Definition:	NowCast is a real-time data product that answers the question of “where is the water right now?”. NowCast is a real-time inundation extent polygon and/or depth raster that provides flood data based on the current river and ocean levels.
		Configuration:	Data is available via geospatial APIs. OGC WFS & WMS standards, as well as ESRI Feature and Image Services. These APIs create new data layers within any Geospatial platform.

		Details:	• NowCast results are refreshed every hour and available to your geospatial platform via an API connection.
			• NowCast status and availability is communicated through the model Availability layer.
			• NowCast contains the following metadata:
			  ○ **published** – UTC timestamp when results were published to the server.
			  ○ **dt_start** – UTC timestamp when the results are valid from.
			  ○ **dt_end** – UTC timestamp when the results are valid to.
			  ○ **floodmapp_reference** – The unique identifying number of the region. This number is used to help identify a specific location when troubleshooting issues.
			  ○ **river_catchment** – The name of the river system of the region.

3	PostCast	Definition:	PostCast is a post-event geospatial data product that answers the question “what was the maximum flood extent and/or depth for this flood event?”. PostCast is a rapid post-event flood inundation map that shows the maximum flood extent and depth from the previous 30 days based on observed stream and tidal gauge station readings.
		Configuration:	Data is available via geospatial APIs. OGC WFS & WMS standards. These APIs create new data layers within any Geospatial platform.
		Details	• PostCast results are refreshed every 12 hours and available to your geospatial platform via an API connection. • PostCast status and availability is communicated through the model Availability layer.

- PostCast contains the following metadata:
  - **published** – UTC timestamp when results were published to the server.
  - **dt_start** – UTC timestamp when the results are valid from.
  - **dt_end** – UTC timestamp when the results are valid to.
  - **peak_start** – UTC timestamp when the flood peaked at the upstream gauge within the region.
  - **peak_end** – UTC timestamp when the flood began to recede at the downstream gauge within the region.
  - **floodmapp_reference** – The unique identifying number of the region. This number is used to help identify a specific location when troubleshooting issues.
  - **river_catchment** – The name of the river system of the region.

Determining if a region was flooding and peaked can be derived from the difference between **dt_end** and **peak_end** values:

- If the difference between **dt_end** and **peak_end** values is more than 12 hours, it indicates the flood waters are receding within that region. Or,
- If the difference between **dt_end** and **peak_end** values is less than 12 hours, it indicates the flood waters are still rising.

5.2 Model Specifications

Item No.	Item	Specification
4	Stream Gauges	• ForeCast, NowCast, and PostCast data are available *only* where gauges exist and are included in FloodMapp's system. There is no coverage of any flooding in ungauged areas. • The stations used to provide observed water levels to support FloodMapp products come from a range of sources, including public and private. The reporting frequency of these stations ranges from once per minute to once per dayFloodMapp does not model pluvial flooding or flooding caused by overwhelmed stormwater networks, unless there are water level gauge sensors in the location that would respond to said flood type. • The stream gauge stations used to support FloodMapp products can change at any time for reason's outside of FloodMapp's control (e.g., permanently decommissioned by USGS). • In the event river level gauge stations fail to provide a recording (i.e., due to damage, etc.), FloodMapp proprietary software will interpolate and model a river level recording. All products may be derived from real or interpolated river level results. Interpolators may vary in reliability. • FloodMapp actively reviews its network of stream gauges supporting the products to provide the best results.
5	Terrain Data	• The quality and accuracy of our products will vary across different areas based on the quality and accuracy of digital elevation survey data and validation data in that area.

			• The horizontal resolution of all results is limited by the underlying terrain model, and any subsequent simplification processes applied to the area of interest. FloodMapp uses the most recent and/or highest resolution terrain studies available. Mapped flood result resolution is at a minimum provided at the following resolutions, given that data of the written corresponding resolution is available:
			  ○ 1-m grid for heavily urbanized areas where 1-m LiDAR exists;
			  ○ 10-m grid for towns and townships with 1-m LiDAR available; and
			  ○ 10-m grid resolution for rural areas.
			• Terrain datasets are not customisable, and the data source is chosen by FloodMapp. Resolutions may be more refined for areas where client need exists.

6	Model Coverage		Product coverage may expand or change at any time.
7	Rendering		• Please note that there may be visual differences when comparing the response from the server using pre-rendered WMS output and raw vector WFS. This is an artifact of the rendering process. If the exact extent is required, e.g. for the purposes of analysis, please use the raw WFS vector data. For adding a visual layer to the map, please use the WMS which is pre-rendered and simplified appropriately to the requested scale.

5.3 Enterprise License Specifications

5.3.1 Impact Analytics Details

Impact Analytics is an operational geospatial data analytics service which is included in an Enterprise Tier License.

Item No.	Item	Sub item	Specification
8	Definition:		• Impact Analytics is an operational geospatial data analytics service. Impact Analytics computes the flooding impacts to people, property, and critical infrastructure based on ForeCast, NowCast, or PostCast. • New results are generated every hour. • Impact Analytics is provided at no additional charge with a client subscription of ForeCast, NowCast, or PostCast (one of the three) at the Enterprise tier. • A client can gain access to one Impact Analytics layer representative of buildings, critical infrastructure, or roadways (subject to limitations) per product.

9	Configuration:	Input data:	• FloodMapp Data
			  ○ Analytics is conducted on the depth raster of either ForeCast, NowCast, or PostCast.
			• External Data
			  ○ Buildings

			▪ National Structures Inventory (NSI) (US only) ▪ Open Street Map (OSM) o Roads ▪ OSM o Assets ▪ HAZUS (US only) ▪ OSM o Customer Provided Points/Lines/Polygons
10		Output Data:	• Web Services o Geospatial data about the impacts of flood on various assets can be computed and made available via APIs, as OGC WFS and WMS standards. These APIs create new data layers within any Geospatial platform. • Example: Depth, duration, and damage estimates for all impacted structures. o Road closures and hazards can be push to the Waze system based on ForeCast or NowCast inundation results. o Note the customer must be a Waze for Cities member. • Notifications o Notification can be sent to predefined recipients based on flood inundation occurring at particular locations or assets. • Example: Send an email if the water is forecasted to reach 2-m at this bridge.

5.3.2 Flood Atlas Details

Flood Atlas is a library of historical flood events which is included within a PostCast Enterprise Tier License.

Item No.	Item	Sub item	Specification
11	Flood Atlas	Definition:	• Flood Atlas is a geospatial data portal that hosts a growing catalogue of historical flooding events. • These historical events may consist of the maximum inundation extent and depth for an individual flood event as well as full event time series. • The portal is hosted via ArcGIS Online with full vector and raster data available for download. • Significant flood events are added every six months per FloodMapp's discretion, although individual flood events can be commissioned based on subscription level. Clients can commission up to 2 historical events per year, in addition to events added at FloodMapp's discretion. • Flood Atlas is provided at no additional charge with an Enterprise tier subscription of PostCast.

12	Configuration:	• Access to Flood Atlas is available via a share group in ArcGIS Online. • Historical flood event data can be downloaded as GeoJSON (vector) or GeoTIFF (raster) files for use within the client's GIS environment.

5.4 Web Service Options

Item No.	Item	Specifications	
13	Web Feature Service	Definition	• Vector Data • Open Geospatial Consortium Standard
		Uses:	• Individual Features contain metadata • Use for analytics of intersections. Ie. Is this point within a the flood extent. • Styling is applied on the client side
		Data	• Polygons of Flood Extents • Points of Impact Locations • Lines of Impacted Streets • Metadata
		Limitations	• Does not show depth. It is true that vector contours can be used to show depth, but the number of vertices this requires makes it impractical.
14	Esri Feature Service		Coming Soon
15	Web Map Service	Definition	• Raster Data • Open Geospatial Consortium Standard
		Data	• NowCast & PostCast & ForeCast o Zoom levels of 1: 150,000 and above show rasters of Flood Extent o Zoom levels below 1: 150,000 show rasters of Flood Depth • Availability • Shows where one can expect to see flood results
		Uses:	• Contains raster data about depth. • Styling is controlled on the server side • Renders much faster than large Vector Datasets.
		Limitations	•
16	Esri Image Service		This feature remains in development.

6 Service Level Specifications

6.1 Service Availability and Reliability

Item No.	Item	Specification
17	Request Rate limits	• Request will be rate limited after 100 requests per second per organization. • Request will be rate limited after 10,000 requests per hour per organization. • Requests over and above this threshold will be queued and may experience degraded performance. • Rate limits increased may be waived during active events.
18	Band-width Download Limits	• Soft cap of 10GB / day. This value is monitored and reported by FloodMapp. • Exceeding this threshold usually requires adding too many users or automating large scale download of several datasets. FloodMapp clients should implement internal data caching and data distribution where there is repetitive or automated use of the same data.
19	Authorised User Limit	• The maximum number of concurrent connections will be stated within the client's current contract.
20	Service Availability	• FloodMapp commits to a service availability of 99.5% on a per quarter basis. • Service availability is communicated through the service status dashboard found at status.floodmapp.com.
21	Service Maintenance	• There will be occasions where the system will be made unavailable to perform regular maintenance and service upgrades to improve models, enhance the product or add new features. • Service maintenance will be scheduled for off peak times. FloodMapp aims to avoid any maintenance performed without cause during flood events. • FloodMapp will provide the customers nominated technical contact with 48 - 72 hours notice for service maintenance periods.
23	Security	• FloodMapp adheres to best practice principles in order to protect applications, systems and data from security risks. • Access to production systems and code is restricted to authorized individuals. • Where Customer data is provided to FloodMapp, data is protected via AWS cloud-based hosting security. Customer data is never shared with any other entity • Customer data may be used to improve models, enhance and otherwise modify the products which may inform another Customer's flood result.

6.2 Product Availability

Item No.	Item	Specification
24	Geographic Reach	FloodMapp's technology requires river level gauging stations to model an predicted, current, and past flood extent. FloodMapp's products are available for all gauged waterways, where FloodMapp has access to the river levels recorded by the gauge, subject to stream gauge station product performance being met.
25	Measurement Stations	FloodMapp has access to many public stream gauge stations. In the event that stream gauge stations fail to provide a recording (i.e., damaged, etc.), FloodMapp proprietary software will interpolate and simulate a river level recording. All products may be derived from real or interpolated river level results.
26	Flooding Sources	Pluvial, luvial (riverine) and coastal (tidal) flood sources are modeled to the extent available from the stream and/or tidal gauge station network. Coastal inundation mapping is only available in areas where a sufficient coastal gauge network exists and where the coastal model is active in the model Availability layer. Flooding driven by coastal surge and simulation of wave energy is not currently a modeled mechanism.
27	Flood models methodology	ForeCast, NowCast and PostCast are powered by DASH, FloodMapp's proprietary rapid flood model. Pluvial rain on grid modelling methods are not included in FloodMapp ForeCast, NowCast or PostCast. While FloodMapp has capability to deliver this methodology, it would be a bespoke/special project and is not covered under our standard license tiers.
28	Model Availability	Regions between river level gauge stations (shown in availability layer) will be marked as Offline, Online, and Validated. The hydraulic performance will determine the status. See product performance for more information.

6.3 Product Maintenance

Item No.	Item	Specification
29	Gauges	• Customers at the Professional and Enterprise tiers can opt to have private stream gauge networks (e.g., non-USGS, NWS, or NOAA) included to improve ForeCast/NowCast/PostCast results. • New gauges will be updated in DASH system 1x per quarter, in the quarter following the clients' request for new gauges to be added. E.g., if a client submits a request for new gauges to be included in DASH on June 1, then FloodMapp staff would add the gauges in the following quarter (July 1-September 30). • Following the conclusion of the onboarding period, no more than 10 new stream or tidal gauges may be added per contract year. If more than 10 gauges are to be added, additional costs may apply.
30	Terrain Data	• Customers at the Professional and Enterprise tiers can opt to have private terrain data (e.g., non-USGS) to improve ForeCast/NowCast/PostCast results. • New terrain data will be updated in DASH system once per annual license, in the quarter following the clients' request for new terrain data to be added. E.g., if a client submits a request for new LiDAR to be included in DASH on June 1, then FloodMapp staff would add the LiDAR in the following quarter (July 1-September 30). • No more than 1 terrain update will be included per annual license.
31	Validation	• FloodMapp is making great advancements on its internal modeling and validation capability all the time, which has the potential to significantly improve the product results in an individual clients' area of interest (AOI). • Re-validation of a client's AOI is available upon renewal of a clients' annual contract, where a minimum 5% licensing increase is applied. This work will be initiated within the first quarter following a client contract renewal.
32	Post-Event Review	• Customers at the Professional and Enterprise tiers can request a post-event review following a flood event to better understand how the products performed and the factors which influenced performance.. • The number of post-event reviews is limited to 2x per annual license. Upon requesting a post-event review, a client can expect a review meeting to be scheduled to initiate the review process within 10 business days of the request being submitted.

6.4 Product Performance

Item No.	Item	Specification
33	Live operational flood forecasting and modeling service	FloodMapp provides highly distributed parallel cloud-based computing method to provide modeled flood extents at local, state, and national scales. Databases are maintained by qualified software engineers.
34	Model Resolution	Mapped flood result resolution is at a minimum provided at a 1-m grid for heavily urbanized areas, a 10-m grid for towns and townships with 1m LiDAR available, and a 20-m grid resolution for rural areas. Resolutions may be more refined for areas where client need exists.
35	Model Availability Layer (for NowCast and PostCast)	**Model status "Validated"** Where 1-m LiDAR exists for the entirety of the gauged model region and comprehensive validation information is available (either client-provided or publicly sourced), results with a "Validated" status are expected to match the observed flood extent within ±100-m for 80% of the mapped inundation area. For areas without full coverage of 1-m LiDAR, the simulated flood extent is expected to be within ±300-m for 80% of observed flood extent for areas of interest (i.e., townships, major transport routes, etc.). Accuracy of modeled results is only relevant for inundated areas where the dominate source of flooding is from an included gauged waterway (i.e., riverine).
36		**Model Status "Online"** Results with an "Online" status are in the process of being validated for a range of flood event magnitudes or results do not meet the performance requirements for "Validated" status. Typically, if the model results are within <±500-m the observed flood extent, the result will be maintained online for the purposes of continuing situational awareness. Catchments may also be in this category if insufficient validation material is available for minor, moderate, and major flood magnitudes and therefore result accuracy cannot be quantified and validated across all event magnitudes. Accuracy of modeled results is only relevant for inundated areas where the dominate source of flooding is from an included gauged waterway (i.e., riverine).
37		**Model Status "Offline"** Where course terrain data (e.g., digital elevation models) or limitations in model processes result in an area where model results are either grossly under- or over-estimated, results are not available to clients in these areas and will be marked as "Offline". Headwater area (where no upstream gauge exists) are o also typically marked "Offline" due to unavailability of accurate results.
38	Model Confidence Layer (for ForeCast)	ForeCast is provided at all gauges within the network where sufficient training and calibration data exists - typically >5 years of continuous data or 5-10 recorded flood events. The models being trained and tested on historical data and therefore model accuracy may not reflect performance during novel flood events that significantly exceed/are different to those recorded in available data. ForeCast model accuracy is communicated through a forecast confidence rating based on how well the model provides an estimate of peak water level with 6hrs lead time, for events greater than minor. Availability of model training data, catchment response time and the meteorological conditions in the immediate lead up to the event all can impact the result. Models are rated as either fit for purpose (peak +/-10%), use with caution (peak +/-25%), use with high degree of caution (peak <50%) or not fit for purpose (peak >50%).

6.5 Customer Support

Item No.	Item	Summary	Specification
39	Types of Support	Support categories	Support requests will be classified as either urgent or non-urgent as defined below: **Urgent:** Support is required and there is a pending or active flooding event. **Non-Urgent:** Support is required and there is no pending or active flooding. See Support Items below for more details on types of urgent and non-urgent support.
40	Types of Support	Minimum service support standard for support categories	**Urgent:** All urgent support requests will be acknowledged within 3 hours for 24 hours a day, 7 days a week, 365 days a year when the client has advised they are involved in an active flooding event. Only Enterprise tier customers have access to urgent support. **Non-Urgent:** All non-urgent support requests will be addressed during business hours within 3-5 business days. • United States: 9 am – 5 pm MST • Australia: 9 am – 5 pm AEST
41	Support Avenues	Ways to notify support is required	A support request can be submitted via one of three mechanisms: • Email: support@floodmapp.com • Website: https://www.floodmapp.com/customersupport • Phone (urgent support requests only): +1 (928) 564-6437 (USA) or + 61 7 4243 4167 (AU)
42	Software Technical Support	Minimum Service support standard	Software support is considered both urgent and non-urgent, per the discretion of FloodMapp staff.
43	GIS Technical Support	Minimum GIS support standard	GIS technical support is considered non-urgent and is provided regarding initial integration of FloodMapp products into the client's chosen GIS environment. All additional GIS support requests (such as analytics using client data or other associated consulting services) are not included in the standard implementation and annual licensing fees.
44	Flood Engineer Technical Support	Minimum Flood Engineer support standard	Flood Engineer support is considered non-urgent and provided for the purpose of discuss anomalies observed in the modeled flood extent products (e.g., post-event review). Response to these queries is aligned with the performance standard for software technical support. Flood Engineer technical support during flood events - such as advice for operational and tactical decision making is not included as part of the standard implementation and annual licensing fees.
45	IT Support Standard	Minimum IT support Standard	IT support (such as lost credentials and the alike) is provided by FloodMapp. All IT support is considered non-urgent.

6.6 Data Sharing

Summary	Details	Can this be shared		Attribution Requirements
		Internal stakeholders within our agency	External stakeholders outside our agency?	
Static maps showing FloodMapp results (ie ForeCast, NowCast or PostCast - excluding bespoke ForeCast modelling requests)	Printed Map	Yes	Yes*	FloodMapp logo included on map
	PDF map	Yes	Yes*	FloodMapp logo included on map
	Static flood extent - Vector file - .shp.kml for	Yes	Yes*	FloodMapp attribution in file name, and metadata.
	Static flood analytics - ie vector file of properties, census blocks, roads	Yes	Yes*	FloodMapp attribution in file name, and metadata.
FloodMapp Dynamic live feed / integrated solution (ie ForeCast, NowCast or PostCast)	Sharing FloodMapp live, operational feeds of flood extent, depth, or impact analytics. • Web feature Service (WFS) • Web Map Service (WMS) • Esri REST service • Esri map service	Yes	No additional FloodMapp license required.	
	Inviting members or end users to Esri ArcGIS online (or Opensource) Group showing FloodMapp live feeds	Yes	No additional FloodMapp license required.	
	Live Dashboard - Esri ArcGIS online or Opensource showing FloodMapp live feeds	Yes	No additional FloodMapp license required.	

* FloodMapp authorizes customers to share static data to external stakeholders outside your organization up to twice a day. Static data can be shared for a single or multiple locations in the customer product coverage per timestep, for up to two timesteps (i.e. hours) per day.

7 Glossary

Term	Definition
ArcGIS	ArcGIS is a family of client, server and online geographic information system software developed and maintained by Esri. ArcGIS was first released in 1982 as ARC/INFO, a command line-based GIS. ARC/INFO was later merged into ArcGIS Desktop, which was eventually superseded by ArcGIS Pro in 2015
AGOL	**ArcGIS Online** a complete, cloud-based mapping platform that allows you to create interactive maps and apps and share them with other team members within or outside your organization.
API	**Application Programming Interface** In the context of APIs, the word Application refers to any software with a distinct function. Interface can be thought of as a contract of service between two applications. This contract defines how the two communicate with each other using requests and responses.
Customer	The commercial entity who has purchased FloodMapp licenses, including any end users of the product.
DASH	**Dynamic Automated Scalable Hydroinformatics.** FloodMapp's proprietary flood modeling software technology
ForeCast	FloodMapp's predictive data mapping product that answers the question "what is the maximum flood extent and/or depth over the forecast horizon?". FloodMapp ForeCast is an operational riverine forecast model which predicts maximum flood inundation extent and/or depth of an impending flood event for a given forecast horizon.
GIS	**Geographic information system(s),** GIS (noun)GIS is a technology that is used to create, manage, analyze, and map all types of data. GIS connects data to a map, integrating location data (where things are) with all types of descriptive information (what things are like there).
GeoJSON	A format for encoding a variety of geographic data structures. **GeoJSON** supports the following geometry types: • Points (therefore addresses and locations), • Line strings (therefore streets, highways and boundaries), p • Polygons (countries, provinces, tracts of land), and • Multi-part collections of these types
Geo TIFF	a public domain metadata standard which allows georeferencing information to be embedded within a TIFF file.
LiDAR	**Light Detection and Ranging** A remote sensing method that uses light in the form of a pulsed laser to measure ranges (variable distances) to the Earth. LiDAR technology is used to survey the

	earth and create high-resolution models of ground elevation with a vertical accuracy of 10 centimeters (4 inches).
NowCast	FloodMapp's live data mapping product that answers the question of "where is the water right now?". NowCast is a real-time inundation extent polygon and/or depth raster that provides flood data updated hourly based on the current river and ocean levels.
OGC	**Open Geospatial Consortium.** OGC is a consortium of experts committed to improving access to geospatial, or location information.
PostCast	FloodMapp's post-event geospatial data product that answers the question "what was the maximum flood extent and/or depth for this flood event?". PostCast is a rapid post-event flood inundation map that shows the maximum flood extent and depth from the previous 30 days based on observed stream and tidal gauge station readings.
WMS	**Web Map Service** a standard protocol developed by the Open Geospatial Consortium for serving georeferenced map images over the Internet. This standard provides a simple HTTP interface for requesting geo-registered map images from one or more distributed geospatial databases. A WMS request defines the geographic layer(s) and area of interest to be processed. The response to the request is one or more geo-registered map images (returned as JPEG, PNG, etc) that can be displayed in a browser application.
WFS	**Web Feature Service** a standard protocol developed by the Open Geospatial Consortium which provides an interface allowing requests for geographical features across the web using platform-independent calls. This standard defines direct fine-grained access to geographic information at the feature and feature property level by specifying discovery, query, locking and transaction operations and operations to manage stored, parameterized query expressions. This standard covers 11 operations e.g. GetCapabilities (discovery operation). This Standard continues to be a reliable means to provide geospatial data to the web. However, the functional capabilities are now available in a more modern web API, OGC API – Features, and implementers are encouraged to use the newer Standard.